Risk Perception and Motivations in Antibiotic Usage and Reduction in Farming Communities in the Mekong Delta Province, Vietnam

Thesis

RISK PERCEPTION AND MOTIVATIONS IN ANTIBIOTIC USAGE AND REDUCTION IN FARMING COMMUNITIES IN THE MEKONG DELTA PROVINCE, VIETNAM

by

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Abstract

To understand both favourable and unfavourable conditions around the efforts to reduce ABU, this study aimed to identify farmers' perception on their health risks posed by the use of antibiotics (ABs) and their motivations for using or reducing antibiotic usage (ABU) on animal farms. A mixed-methods approach, in two phases, was employed to study a cohort of 100 smallholder farmers, who owned small or medium-sized animal farms, in southern Vietnam.

Farmers had limited understanding of ABU and antibiotic resistance (ABR). Generally, they were unaware that ABs were used for treating bacterial infections (87, 87%), and that misusing ABs for food-animals could exacerbate ABR (77, 77%). Although farmers believed they used ABs in a “considered manner”, they self-prescribed (96%) and self-administered (77%) ABs for their animals. In practices, they accessed ABs over-the-counter to “supplement” ABs into medicated-commercial feed (49, 60.5%). They preferred their own experience (49, 60.5%) to consultations from local veterinarians (7, 8,6%) in making decisions about ABU due to own concerns about poor veterinary services. Attending local training events organized by vet-drug companies was identified as the risk factor for farmers to adopt ABU for non-therapeutic purposes [OR 4.1, 95% CI (1.2-14.4)]. Almost none of the farmers had any idea about ABR bacteria as a type of zoonoses. Instead, they were concerned that antibiotic residues would reduce food safety, which was also one of the non-economic considerations motivating the intentions and efforts to reduce ABU for animals among ‘Pioneer farmers’ (14, 17.3%). The latter was one of the three groups of farmers, whose willingness to reduce ABU was characterised to subgroup into ‘Pioneer’, ‘Hesitant’ and ‘Conventional’ farmer group.

Overall, the results indicated farmers' poor awareness of ABR and inappropriate ABU, poor law compliance towards ABU regulation, and the untrusted relationship of farmers to local veterinarians. These were the unfavourable conditions in the public health's efforts to reduce ABU. However, the example of the intention and efforts of 'pioneer farmers' were important in engaging other farmers in the practice of ABU reduction. 'Pioneer farmers' can act as a bridge between external resources and internal community efforts to promote appropriate ABU.

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Abbreviations

ABU	Antibiotic usage
ABR	Antibiotic resistant; Antibiotic resistance
AB; ABs	Antibiotic; Antibiotics
AGPs	Antibiotic growth promoters
ABP	Practices of using antibiotics
AIPED	Vietnam integrated national operational program on avian influenza, pandemic
ASF	African swine fever
CDS	Communicable diseases
CAHW	Community animal health workers
EIA	Environmental impact assessment
EIDs	Emerging infectious diseases
EM	Effective anti-microorganism product
EU	The European Union
FAO	Food and Agriculture Organization of the United Nations
FMD	Foot and mouth disease
GAHP	Good Animal Husbandry Practice
GAP	Global Action Plan
GDP	Gross domestic product
GSO	General Statistics Office of Vietnam
HICs	High-income countries
HPAI	Highly pathogenic avian influenza
KAP	Knowledge – Attitude – Practice
LMICs	Low-middle-income countries
MARD	Ministry of Agriculture, Rural and Development
MOH	Ministry of Health
MONRE	Ministry of Natural Resources and Environment
OHSP	The One Health strategic plan
OIE	World Organisation for Animal Health
OPI	National Operational Program for Avian and Human Influenza
PRRS	Porcine Reproductive and Respiratory Syndrome
PPE	Personal protective equipment
SDAHH	The sub-department of animal health and husbandry
SPSS	Statistical Package for the Social Sciences
UK	The United Kingdoms
UNICEF	United Nations International Children's Emergency Fund
USA	The United States
WHO	World Health Organization
ZD	Zoonotic diseases

Abbreviations in Vietnamese (names of law documents)

BNNPTNT	MARD – Ministry of Agriculture, Rural and Development
BYT	MOH – Ministry of Health
QĐ-BNN-TY	Decision-MARD-Veterinary
QĐ-BNN-CN	Decision-MARD-Animal husbandry
QĐ-TOT	Decision of Prime Minister
NQ-CP	Resolution-Government
ND-CP	Decree-Government
CT-BTS	Decretive-Ministry of fisheries
TT-BNN	Circular- MARD

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Chapter 1

Introduction

1.1 Background of the study

Global efforts to reduce antibiotic usage for food animals to deal with antibiotic resistance

The rapid emergence of antimicrobial-resistant microorganisms is one of the greatest challenges for public health and requires global efforts to combat (O'Neill, 2014; Robinson *et al.*, 2016; WHO, 2015c). Human pathogenic microorganisms have become resistant to nearly all classes of antibiotics (ABs) and many of those have evolved into multidrug-resistant forms (Gootz, 2010). This is coupled with the fact that we are running out of new ABs due to the current slow pace of AB discovery compared to the period between 1940 and 1960 (Coates *et al.*, 2011). Antimicrobial-resistant infections have been reported to cause 700,000 deaths annually and projected to increase to ten million by 2050 if no actions are put in place to tackle this global problem (O'neil, 2016). Together, this may warrant a return to the dark ages of medicine.

Any use of ABs can contribute to the development of ABR, whether for human or animal use (S. C. Davies & Gibbens, 2013). However, the unnecessary widespread and excessive use will intensify this effect (WHO, 2020). Globally, more than 130,000 tons of ABs were used in animals in 2013, accounting for approximately 70% of the consumption (Boeckel *et al.*, 2017). It is estimated that agricultural AB consumption will increase by 67% by 2030 due to the growth in demand of animal-food products, especially in the low-middle-income countries (LMICs) (Boeckel *et al.*, 2015). A lack of ABs used exclusively for treating animal diseases without posing a threat to human health has played a major role in this current global issue (Marshall & Levy, 2011).

The concern that ABR could threaten human health via antibiotic usage (ABU) in food-producing animals was first raised in the 1960s (Watanabe, 1963). After the warnings of the Swan Committee Report in 1969 that ABs must be designated for therapeutic purposes, Sweden, and subsequently Denmark, took the initiative to ban the use of all antimicrobial growth promoters in pig and poultry production in 1986 and 1988, respectively (Kahn, 2016). The World Health Organization (WHO) raised a discussion on the medical impacts of the use of ABs in animal production in 1997 (WHO, 1997). Then, there were calls for a reduction of unnecessary ABU or a sustained decrease without major impacts on productivity (FAO, 2016b; Marshall & Levy, 2011; O'Neill, 2014; OIE, 2016). Among strategies for prudent ABU, Food and Agriculture Organization (FAO) highlighted phasing out the use of ABs as growth promoters, replacing preventative ABU with other measures (FAO, 2019). According to guidelines from World Organisation for Animal Health (OIE), a veterinarian should be responsible for ABU decisions on animal farms, including prescribing and administering appropriate ABs, and this should be based on clinical experience and diagnostic laboratory information (OIE, 2015). In 2006, an European Union (EU)-wide ban on ABU as growth promoters in feed was introduced as the final step in the phasing out ABU for non-medicinal purposes started in the 1980s (Levy, 2014). The reduction of ABU in agriculture via implementation of policies in EU countries was seen as a successful model (Kahn, 2016). Before the introduction of the ban, the model of the EU animal husbandry sector was the intensive farming system (Zanten *et al.*, 2016). Moreover, the sector has benefited from The Common Agricultural Policy aiming to stabilize farmers' income and budget (Lefebvre & Espinosa, 2012). Studies have shown that in general the ban did not result in a long-term decrease in pig and poultry production (Aarestrup *et al.*, 2010; Emborg *et al.*, 2001; Wierup, 2001). The ban further supported Sweden's goal to have the "cleanest agriculture in the world". However, this

led to many small Swedish farmers going out of business due to poor profitability. In Denmark, over the 20 years spanning the ban (1993-2013), small and medium pig farms decreased by 95% and 76%, respectively (Kahn, 2016).

In 2015, the Global Action Plan (GAP), under tripartite cooperation of FAO, OIE and WHO was introduced to respond to the ABR issue (WHO, 2015c). The plan acknowledged the overlapping of AB classes for both human and animal use; the existence of zoonotic ABR bacterial pathogens, and a lack of a geographical borders in the spread of ABR (O'neill, 2016). However, countries with economic limitations may make little progress in the development of national action plans to combat ABR emergence (European_Food_Safety, 2018). This would affect the impact of GAP since implementation would not occur simultaneously, while ABR pathogen could still spread without borders. Moreover, there was still a lack of unified regulations to formulate strict policies for AB stewardship in both human and animal health sectors (Walia *et al.*, 2019). These aforementioned issues show a major challenge and a gap for food animal producers in low-middle income countries (LMICs) such as Vietnam to start reducing ABU in animal husbandry.

Animal husbandry and ABU in Vietnam

Vietnam is an agricultural country, where crop and animal production plays an important role in Vietnam's national economy and poverty reduction by providing significant sources of work and income for poor rural people (WorldBank, 2016). In 2018, it provided employment to over 40% of the total labour force (54 million people), of those, 43% (9.5 million labourers) work in this sector (GSO, 2018). Accounting for ten percent of the population of Vietnam (97 million people), this figure is much higher than that in other high-income countries (HICs). For example, in the United

Kingdom (UK), the number of employees in agricultural holdings are 306,000 people, accounting for just 0.5% of the total population (approximately 66.3 million people) (DEFRA, 2019). Generally, the animal husbandry sector in Vietnam is still tightly linked with Vietnamese farmers' livelihoods in rural areas and is characterized by being small and fragmented (Dinh & Hilmarsson, 2014). It was estimated that around seven million households kept pig and poultry for commercial purposes, in which around 70% were smallholders owning less than 20 pigs or less than 100 heads of poultry (GSO, 2016b). Small family-oriented farms still dominate the livestock sector (70%) and contribute significantly to total livestock products (30%) (GSO, 2016b). However, there is still a lack of policies to support farmers' incomes and livelihoods in managing farming risks (Tuan, 2010). The current food animal production system in Vietnam just sufficiently supplies domestic demand and has been vulnerable to animal disease outbreaks, which may lead to a shortage of meat supply in the country (WorldBank, 2016). This has been observed by the fact that the current price of one kilogram of live weight pork in October 2020 (80,000 VND, ~3.5 USD) is almost double that prior to the outbreak of African swine fever (ASF) in February, 2019 (40,000 VND, ~1.75 USD) (Nhien, 2020).

With regard to agricultural policy, since the 2000s, the government commenced introducing policies and measures to support the growth of animal husbandry by stimulating production and yield to meet increasing domestic demand and to promote the development of high-quality products for export (Resolution-09/2000/NQ-CP, 2000). However, this plan was interrupted between 2004 and 2007 with the occurrence and rapid spread of diseases in pig and poultry production. The subsequent plans for stimulating the growth of this sector included the focus on biosecurity and good farming practices for disease control, raising high economic benefits and sustainable development in this sector. Among the growth plans, policies since 2016 also started

to highlight efforts to reduce ABU in food animal production to combat ABR. The Vietnam One Health Strategic Plan (OHSP) for the period from 2016 to 2020 focused on the continued development of capacities to reduce the health and other impacts of zoonotic diseases and diseases of animal origin (MARD & MOH, 2016). Zoonotic diseases (ZD) defined in Vietnam OHSP included zoonotic influenza, rabies, ABR and foodborne illnesses. Besides that, national action plans to combat ABR were introduced, first in the human health sector (Decision no. 2174/QĐ-BYT, issued by MOH in 2013) and then expanded to the animal health sector (Decision no. 2625/QĐ-BNN-TY in 2016). The current agenda is focused on seeking solutions to reduce ABU, of which, the first step was to ban antibiotic growth promoters (AGPs) in animal husbandry since 2018 (Decree 39/2017/ND-CP issued by the Government in 2017).

1.2 Rationale of the study

Although smallholder farms in Vietnam just contribute up to 30% of the total food-animal production, they provide employment and income for at least 10% of the total Vietnamese population. Raising pigs and chickens was also a means of poverty reduction in the rural areas. Therefore, if the smallholder farmers could be particularly affected by the ban like lessons from the EU countries, it could become an important social issue.

I was interested to learn whether farmers thought that they overused ABs on their animal farms and if they recognized the risk to their health due to zoonotic infections, and whether farmers perceive and are concerned about zoonotic infections and ABR be motivated to reduce ABU in animals.

The aim of this study is to identify the perception that smallholder farmers have on the risks to their health and existing motivations for AB use and reduction in animals. This study focuses on

collecting data, characterizing and analyzing farmers' knowledge related to farming practices, as well as health risks, motivations and values that they are pursuing in adopting ABU on farms. The findings will allow us to promote smallholder farmers to appropriate ABU for animals through feasible interventions, which will be developed with potential favourable and unfavourable conditions identified in this study.

1.3 Aims of the study

Through this study, I aim to understand farmers' perceptions towards ABU, ABR and zoonotic infections, including ABR pathogens and their motivations for ABU to identify both favourable and unfavourable conditions for the efforts to reduce ABU on pig and poultry farms.

The specific objectives are:

- To characterize farmers' understanding, attitudes and practices towards ABU and ABR.
- To describe farmers' perception of zoonotic infections and the risk to their health working on farms.
- To describe farmers' responses towards the withdrawal of ABs from commercial feed and their practices of ABU for non-treatment purposes.
- To assess farmers' motivations and values in making decisions related to ABU and reduction.

It is intended that the findings in this study will provide information to understand potential favourable or unfavorable conditions to promote smallholder farmers to reduce their ABU on farms. These will enable us to propose feasible interventions to further engage farmers in the efforts for the benefit of public health.

1.4 The outline of the thesis

Chapter Two provides an outline of the physical setting for this study. It includes a description of the characteristics of animal husbandry in Vietnam and the dynamics of national policies for promoting the growth of this sector. The policies are related to manage environmental pollution caused by animal production, control animal diseases based on One Health strategies, and monitor the use of veterinary drugs, including ABs. The description provides a picture of the social context that farmers are embedded in to further understand their reasons for ABU and other practices on farms. The main message from this chapter is that animal husbandry in Vietnam is in a transitional stage with both opportunities and challenges; and that the system of introducing policies to handle disease outbreaks and stimulate production and yield in Vietnam has been in line with global policies.

Chapter Three presents a review of the literature relating to the relationship between ABR and food animal production, global responses to ABR as well as the social dimensions of ABR under social science approaches. Focusing on individual practices and decisions, this chapter also presents the flow of decision-making theories and of factors determining farmers' practices and behaviours. The chapter ends with the identifications of the limitations of previous studies about the relevant issues and the main research questions driving this study.

Chapter Four presents a broad methodological strategy of the study. It includes the study design, methods used for data collection, and methods of data analysis. This study was designed with a mix of quantitative and qualitative research methods. The data collection process included two phases. Phase one, in 2016, focused on a survey of knowledge, attitude and practice (KAP) on a cohort of 100 farmers who were raising pigs or chickens. Phase two dealt with qualitative methods with individual interviews with 81 farmers and in-depth interviews with 15 farmers who were in the original cohort of 100 farmers recruited in 2016. The chapter also presents the analysis

frameworks used for the KAP survey and the qualitative research. The details of data collection and analysis will be reported in each result chapter.

Chapter Five presents the results of the KAP survey to explore farmers' understanding of ABU and ABR, their attitude towards ABU and factors influencing their decision making process in using ABs for their animals. The findings are that the majority of farmers have a limited knowledge of ABU and ABR, and they still conduct inappropriate ABU on farms such as using ABs for non-treatment purposes or self-adjusting the AB dose based on their experiences. Importantly, the majority of farmers acknowledged the necessity of ABU for animals and they did not think they abused the use of ABs. About one-third of the study farmers had tried to apply alternatives to ABs when possible. This was due to their perception of potential adverse side effects of ABU to animal health and production costs. Limited understanding of ABU and ABR was not significantly associated with inappropriate ABU. However, perversely, the participation of study farmers in training events showed a significant association with ABU for non-therapeutic purposes.

Chapter Six also presents a part of the KAP survey for farmers' awareness towards their risk of contracting zoonotic infections, including ABR pathogens. The findings suggest that farmers underestimated the possibility of contracting diseases from farm animals, and they did not recognize zoonosis as a health risk. Their farming practices were mainly based on dealing with animal diseases rather than on protecting farmers' health. Therefore, in engaging farmers in efforts to reduce ABU, the intervention strategies should not focus on human health issues since farmers prioritize animal health care and productivity over human health. The focus should be on effective alternatives to ABs for reducing the threat of ABR in animal health.

Chapter Seven presents the findings of examining farmers' concern towards the presence of ABs in commercial feed and their practices of using ABs for non-therapeutic purposes. In the context that the government commenced the road map for banning ABU for growth promotion in commercial feed in 2018, the chapter aimed to identify the farmers' potential reactions during the study period of 2016 to 2017 towards this plan. The findings were that farmers showed little concern about the presence of ABs in commercial feed; and they commonly added ABs into medicated commercial feed for prophylactic and growth promotion purposes (60.5%). These finding suggested that adding ABs into feed was not only performed by feed producers, but also by farmers. The latter may prejudice the policy to ban ABU in feed for growth promotion due to the fact that farmers could obtain ABs over the counter. Another important finding was that farmers had different concern about and response to the impact of sub-therapeutic ABU on economic income, and human and animal health consequences. Observing farmers' intention and practices of ABU, the study results divided them into three groups. I would like to call them as 'pioneer', 'hesitant' and 'conventional' farmers. 'Pioneer farmers' (14, 17.3%) showed their willing to stop ABU for sub-therapeutic purposes and experienced with effective solutions for preventing diseases and stimulating animal growth without ABU. 'Hesitant farmers' (29, 35.8%) also showed their intention to reduce sub-therapeutic ABU, but they were still looking for effective solutions. 'Conventional farmers' (38, 46.9%) did not intend to reduce ABU and were practising sub-therapeutic ABU. However, this chapter did not have in-depth analysis to interpret motivations driving different responses of these farmer groups.

Chapter Eight displays the findings of qualitative analysis of the motivations of 'pioneer', 'hesitant' and 'conventional' farmers in this practice to explore feasible solutions for engaging them in efforts to reduce ABU against ABR for public health. Overall, all interviewed farmers

were aware of the major changes of animal production and the challenges they had to face from the growth of this sector. However, farmers from different groups had different responses to their challenges. While pioneer farmers showed their confidences in adopting alternatives to ABs for sub-therapeutic purposes, the other farmer groups showed their uncertainty about loss and gain towards AB reduction. In addition, farmers should not be considered purely as economic men when their decisions were motivated by both economic and non-economic values. Pioneer farmers were pursuing the values of responsibility and competence to produce the highest quality of animal products. Hesitant farmers highlighted the moral obligation to produce safe animal products to serve consumers. To conventional farmers, their values were humanity and sensitivity in taking care of animals.

Chapter Nine commences with a summary of the main study findings and discussed the favourable and unfavourable conditions for the efforts to reduce ABU in animal husbandry. Farmers' limited understanding of ABR and their inappropriate practices of ABU, the untrusted relationship of farmers to veterinarians, and the poor law enforcement of ABU regulations are defined as unfavourable conditions for ABU reduction. The commitment of the government to ABU stewardship and ABR surveillance since 2016 could be seen as a favourable factor which could stimulate appropriate ABU among farmers. However, interventions to reduce ABU could negatively impact on smallholder farmers' interests, as lessons from Denmark or Sweden. Therefore, smallholder should be engaged and considered as partners in efforts to reduce ABU to mitigate their own potential harms. A bottom-up approach to promote behaviour change among farmers and to engage them in the efforts to reduce ABU could be from the grassroots levels via the role of 'pioneer farmers', who will act as models for motivating other farmers to change. This chapter also discusses ideas for ongoing studies and the limitations of this study.

Chapter 2

ANIMAL PRODUCTION IN VIETNAM

2.1 Geographical locations, population and GDP growth

Vietnam is a tropical monsoon country located in Southeast Asia with a mid-size territory of 331,222.6 square kilometers. The country shares a boundary with China in the North, and Laos and Cambodia in the West. The boundary in the Southwest, South and East is a 3,260 km long coastline.

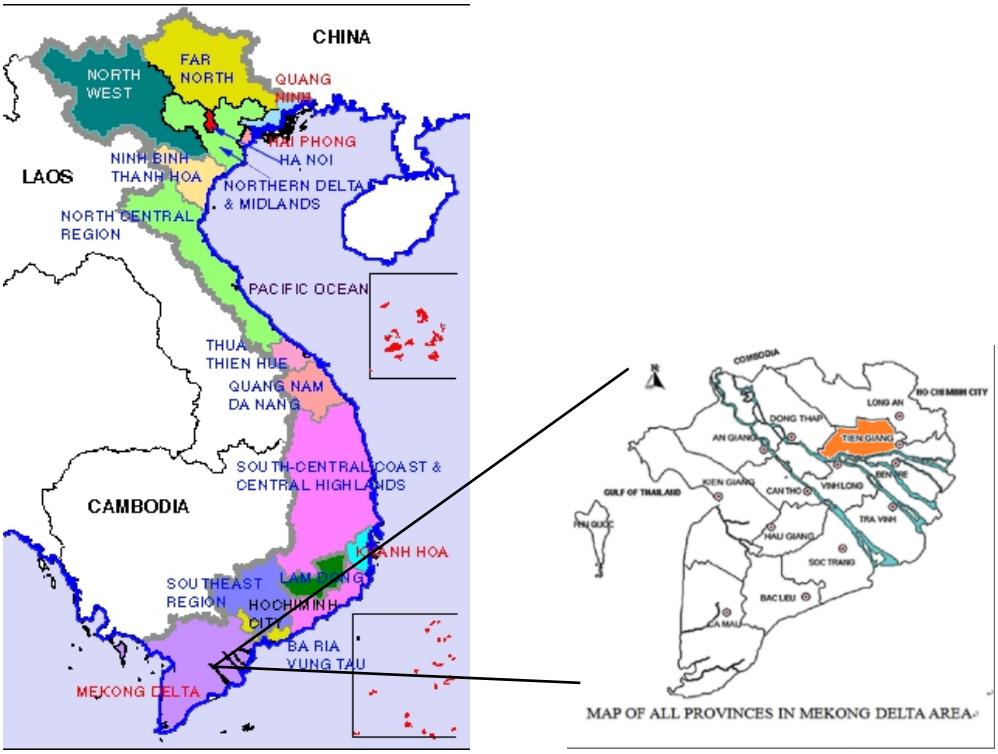


Figure 2.1 Map of Vietnam and the Mekong Delta Region

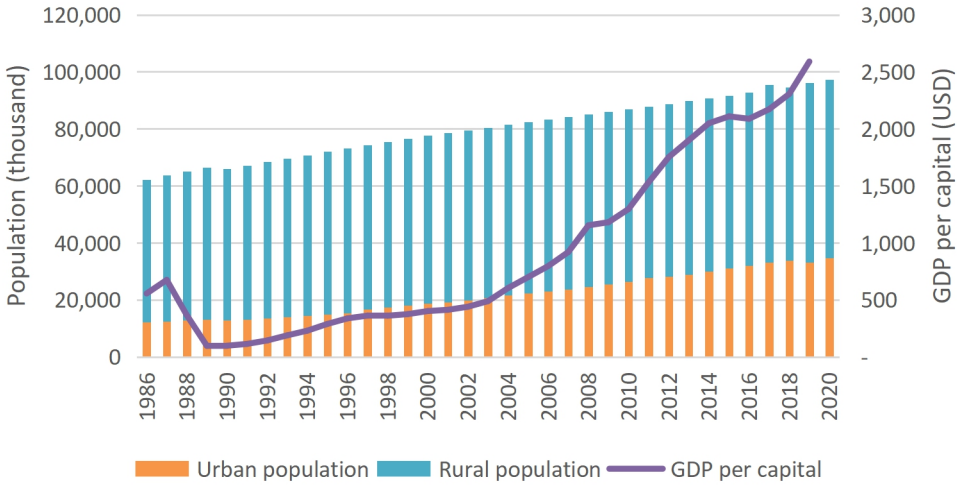
Source: (Q. C. Nguyen & Ye, 2015)

With a distance of 1,665 kilometers spreading from the North to the South, the country is divided into three main regions, namely the Northern (including Northwest, Northeast and the Red River

delta), the Central (including North and South central coast and Central Highlands) and the Southern (including Southeast, Mekong River Delta regions). The study site was in Tien Giang, a province located in The Mekong River Delta (Figure 2.1).

The population in Vietnam in 2020 is about 97 million, increasing from about 62 million in 1986. Of those, more than 70 million (72.2%) are in the workforce (GSO, 2020). Although more than 62 million people (64.4%) are located in rural areas, the urban population is increasing significantly, accounting for 19.6% to 35.6% of the population between 1986 and 2019, respectively. The annual gross domestic product (GDP) growth rate of Vietnam has significantly increased since 1990, with an average growth rate of 6.5% between 1990 and 2019. In this period, per capital income also increased substantially, from $556 to $2,590 (Figure 2.2). However, due to the spread of COVID-19, the annual economic growth is anticipated to slow down to 4.8% in 2020.

Figure 2.2 Population and GDP growth in Vietnam, between 1986 and 2020

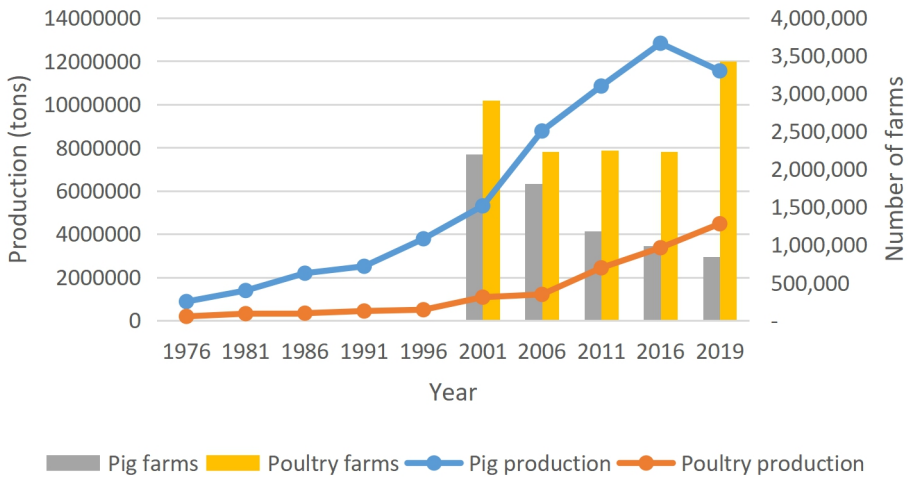


Source: (GSO, 2020; WorldBank, 2020)

2.2 Animal production: Growth, threats of environmental pollution, animal diseases and antibiotic use as a solution

The growth of the animal husbandry in Vietnam since the 2000s has been considered as the inevitable result of rapid growth in both the economy and population, which has led to an increase in local meat demand (AJICA, 2013). The share of this sector in total agricultural production increased from 20% in 1995 to 35% in 2019 (GSO, 2019; OECD, 2015). Pork and poultry dominated meat production in this country with respective shares of meat at 71.5% and 20.6%, much higher than the shares of buffalo and beef (GSO, 2019). In 2019, total poultry had reached 409 million heads, of which chickens accounted for 77.5% (GSO, 2019).

Figure 2.3 Numbers of animal production and farms between 1976 and 2019*



Data source: (FAOSAT, 2020; GSO, 2020)

* No data for number of pig and chicken farms before 2001. Until 2001, the government launched the first national survey for the socio-economic context in rural areas and agricultural, forestry and fishery production to collect data about number of livestock farms.

In the past, pigs or poultry were kept for semi-subsistence purposes, to provide the household with fresh meat or as a source of saving a sideline income. Between 1976 and 2019, this sector witnessed a significant transitional stage from semi-subsistence to intensive farming for commercial purposes with a growth trend of production and an up-scaling of farms. Production has now become a main source of household income, targeting to not only meet domestic needs, but also to expand to export markets. Pork and poultry production recently still served mainly the domestic market and a very small proportion of the total production was exported to foreign markets (GSO, 2018). Despite good development, this sector has faced many challenges, including the prevalence of periodic outbreaks of some infectious diseases which puts smallholder farmers' livelihoods at risk (FAO, 2009).

The number of pig farms decreased significantly by 62% during the period 2001 and 2019, mainly in small-household farms keeping one to five pigs. However, of 2.9 million pig farms in 2018, small farms having less than ten pigs were still dominant, accounting for about 70%. Despite the reduction of farm numbers, pig production increased steadily over the 18-year period despite severe outbreaks of Foot and Mouth disease (FMD) or Porcine Reproductive and Respiratory Syndrome (PRRS) before slightly reduced due to the outbreak of African Swine fever (ASF) in late 2018 and 2019. Regarding poultry production, an upward trend was seen in both number of farms and poultry production. Between 1976 and 2019, poultry production increased three times in the total herd. The number of farms also grew by 18% and small farms having less than 100 birds were still dominant, accounting for more than 75% during the period 2001 and 2019 (GSO, 2019). Rapidly expanding pig and chicken production was exerting massive pressures on the environment, exacerbating environmental degradation and challenging long-term productivity growth because of animal diseases (OECD, 2015). A high volume of animal manure generated and discharged into

the environment resulted in different types of pollution through the contamination of surface water, ground-water, soil and air (Tung, 2017). Waterborne or airborne diseases causing impacts on animal health and subsequent economic losses were reported (Sundström *et al.*, 2014). For example, since late 2003, Vietnam has witnessed the detrimental effects of the Highly Pathogenic Avian Influenza (HPAI), subtype H5N1, causing 55 million birds to die or be culled (Vu, 2009). Just after the first outbreak in 2003-2004, there was an approximate 15% decline in production and an estimated economic loss of 0.1 to 0.2 percent of GDP or $250 million (Brahmbhatt, 2005; WorldBank, 2015). In pig production, between 2007 and 2010, thousands of PRRS outbreaks occurred and nearly 400,000 pigs were affected and died (Zhang & Kono, 2012). About 1,767 outbreaks of FMD occurred, causing thousands of pigs to be lost between 2007 and 2012 (T. Nguyen *et al.*, 2013). Until now, FMD outbreaks occur annually at the provincial level with thousands of pigs being infected or dying (Vietnamnet, 2019). Just after the FMD outbreaks, ASF occurred for the first time in the northern provinces and spread to all 63 provinces in Vietnam in early 2019, resulting in the loss of nearly six million pigs (GAIN, 2019).

About 70% of pig and poultry farms in Vietnam still remain in small scale production (GSO, 2019). Smallholder farms were reported to contribute 40% of total animal manure discharged directly into the environment (Tung, 2017). Smallholder farmers have faced many constraints in applying safe waste management practices and other hygiene applications, such as poor perception of safety measures, unfavourable farming conditions and the lack of adherence to existing regulations (Veidt *et al.*, 2018). Consequently, their production is threatened by poor productivity due to a high risk of infectious diseases among animals (Coker *et al.*, 2011). This problem stimulates antibiotic use (ABU) as a solution to protect productivity and contributes to the generation of ABR (An, 2009; Coker *et al.*, 2011; K. V. Nguyen *et al.*, 2013; Sundström *et al.*,

2014). More than 71% of ABs used in Vietnam are estimated to be for animals, of which pigs and poultry consumed about 46% of the total (Carrique-Mas *et al.*, 2020). It was also estimated that AB consumption for animals would increase by 157% between 2010 and 2030 (Boeckel *et al.*, 2015). To deal with animal diseases and protect productivity, smallholder farmers used ABs for both therapeutic and non-therapeutic purposes (Carrique-Mas *et al.*, 2015; Pham-Duc *et al.*, 2019). This matter raised concern about the wide prevalence of ABR fostered by the indiscriminate use of ABs by farmers in countries such as Vietnam (Manyi-Loh *et al.*, 2018). Some reasons had been found, such as smallholder farmers lack the knowledge of the prudent use of these drugs and the perception of economic advantage in using ABs compared to economic losses due to animal diseases (L. Coyne *et al.*, 2020; Kim *et al.*, 2013).

Overall, Vietnam has witnessed a significant growth of animal husbandry for about two decades, especially in pig and poultry production. Both the scale of farming and animal population has expanded, resulting in concerns about environmental degradation due to poor waste management practices and hygiene application. Consequently, infectious diseases among animals have become the main challenge threatening farming productivity and economic profits, especially to smallholder farmers who lack favourable conditions to manage waste better and control disease. Subsequently, the volume of ABs used for food animals is growing as a solution to deal with animal diseases.

2.3 Overview of policies related to animal husbandry in Vietnam

The aim of this overview is to examine how policies take into account smallholder farmers to understand both advantageous and disadvantageous contexts that these farmers are embedded in. This overview will describe an image of the animal husbandry via policy dynamics in Vietnam

from 1975 to current, focusing on strategies of growth, biosecurity practices and environmental protection, solutions to deal with animal diseases and monitor ABU (Figure 2.4). The relevant regulations to animal husbandry in Vietnam, mainly found since 2000, were accessed through a website www.vanban.chinhphu.vn, which is a formal government portal of the Socialist republic of Vietnam. Information about title, number and main content of these documents was taken note and organized to identify the changes in relevant policies and laws by years (Appendix Chapter 2: A summary of relevant regulations).

2.3.1 Strategies to promote animal sector development

Generally, between 1975 and 2000, policies in agriculture focused mainly on crop cultivation with reforming land use and tax to create further empowerment for farmers to manage main production materials and their products. After 2000, the government commenced undertaking the policies and measures to support the livestock and poultry sector growth by stimulating production and yield to meet increasing domestic demand and promote the development of high-quality products for export (Resolution-09/2000/NQ-CP, 2000). Among a few policies aiming to develop this sector between 2000 and 2005, the main topics were solutions to remedy issues of food safety, sanitary issues, and animal diseases which were the barriers for competitiveness and for establishing export markets. However, actions to actualize these solutions seem to have been interrupted due to the emergence of animal disease outbreaks, such as H5N1 in poultry or PRRS and FMD in pigs between 2005 and 2007. Then, the strategy for animal husbandry development and the plan to restructure animal farming was introduced in 2008 (Decision-10/2008/QĐ-TOT, 2008) and 2014 (Decision-984/QĐ-BNN-CN, 2014), respectively. These plans highlighted that the barriers to the growth in this sector were related to small-scale and fragmented farms, resulting in less

competitiveness, poor added value and environmental pollution. Therefore, the main strategies were to restructure the livestock and poultry sector, to gradually convert small-scale household farms to commercial, and to promote competitiveness, added value and sustainable development contributing to social security and environmental protection. These are long-term plans with a more comprehensive approach, in which the multiple factors of production, environmental protection, and animal health are perceived as connected and challenging to the sustainable growth of the livestock husbandry. Until recently, the animal sector is still struggling with the dominance of small-scale production, environmental pollution and disease outbreaks.

2.3.2 Policies to promote biosecurity practices and environmental protection

In 2005, Ministry of Agriculture, Rural and Development (MARD) issued detailed regulations for promoting biosecurity practices on poultry farms as solutions to prevent the introduction of animal diseases after the severe outbreaks of H5N1 (Decision 3065/QD-BNN-NN, 2005). For example, poultry farms having less than 200 birds have to be separate from household houses; farms having more than 200 birds have to be located far from residential areas; farming areas have to be disinfected frequently according to veterinary agency regulations; and farms must have solutions to treat animal waste and deaths. Two of four prohibited acts are “causing environmental pollution, not ensuring hygienic veterinary conditions” and “not proactively informing authorities of epidemics, spreading disease sources, and selling infected or dead poultry” (Article 4, Decision 3065/QD-BNN-NN, 2005). In 2008, MARD promulgated Good Animal Husbandry Practices (VietGAHP) for pigs and poultry (Decision 1504 & 1506/QD-BNN-NN, 2008) to encourage farmers to apply good practices in order to prevent risk from disease infections, to improve product safety and quality, and to protect human health and the environment. However, adopting

VietGAHP standards is still voluntary. VietGAHP farms are required to demonstrate their ability in farming management, waste treatment, solutions for preventing or dealing with animal diseases, and keeping all farming records to show their commitment in providing safe and qualified products.

Regarding waste management and environmental protection, after the passing of the Environmental Protection Law in 2005, the government provided guidance on the implementation of this law in 2006 (Decree No. 80/2006/ND-CP by the Prime Minister, dated August 9, 2006). According to this legal document, large farms with more than 1,000 pigs or 20,000 poultry, are required to carry out an environmental impact assessment (EIA) before their establishment to ensure their capability in managing waste and environmental pollution. Small-scale farms are required to submit an Environment Protection Commitment Letter to District or Commune People's Committee level to report their solutions for environmental issues. Then, in 2010, MARD introduced the Vietnam National Technical Regulation Conditions for Biosecurity of Pig and Poultry to provide procedures for inspection, assessment and certification of hygienic conditions applicable to cattle, pig and poultry farms registered for business operation under the administration of MARD (QCVN 01 - 79: 2011/BNNPTNT). However, similar regulations or procedures to monitor farming operations in smallholder farms have not yet been issued.

2.3.3 Policy responses to animal diseases

The period between 2004 and 2020 has witnessed severe epidemics in pigs and poultry such as H5N1, FMD, PRRS and ASF causing production losses (section 2.2). To deal with this issue and protect the growth of this sector, three groups of solutions have been introduced for active prevention and risk management. These are the policies of compulsory vaccination, culling of

infected animals, and compensation and agricultural insurance. Beneficiaries of these policies are all animal producers, including smallholder farmers.

2.3.3.1 Policy of compulsory vaccination

After the first wave of H5N1, MARD promulgated regulations on compulsory vaccination for livestock and poultry in Decision No. 63/2005/QD-NN issued in 2005. The list of diseases for vaccination include FMD, Swine Cholera, Anthrax, Pasteurellosis, Rabies, Newcastle Disease and Fowl Cholera. These also belong to a list of diseases in animals and animal products subjected to mandatory testing and quarantine before being transported out of the province (Circular 25/2016/TT-BNNPTNT, dated 2016). Between 2005 and 2016, farmers were not required to pay the cost for compulsory vaccination but they had to show records of vaccination for quarantine purposes. After 2016, the State stopped covering the cost of vaccination. However, farmers were still required to comply with the compulsory vaccination program if they wanted to transport their animals out of the provinces with a veterinary quarantine certification, and be entitled to the subsidy policy if epidemics occurred. The compulsory vaccination program aims to control outbreaks of animal diseases and reduce the burden of the subsidy policy if outbreaks occur.

2.3.3.2 Subsidy policy for preventing epidemics from spreading

The purpose of this subsidy policy is to stimulate farmers' compliance in the event of the culling of infected animals in order to prevent the epidemic from spreading. Livestock and poultry farmers, regardless of scale, will receive a compensation payment as support to recover production costs. Between 2004 and 2019, the government adjusted the compensation levels several times to adapt to the current market value. For example, the compensation level for birds culled in 2004 was 5,000 VND/head (0.32 USD) and 10,000 VND/kilogram for pigs (~0.64 USD) in response to the FMD epidemic in 2006. In 2018, the average compensation was 35,000 VND/head for poultry

(~1.7 USD) and 38,000 VND/kilogram for pigs (~1.85 USD). However, generally, the compensation rates were criticized as much lower than the market price. Therefore, the government is continuing to adjust the compensation rates more practically. For example, in response to the outbreaks of ASF, The Prime Minister issued a new compensation policy in which the rate would depend on the type of pig: sow, fattening or piglets.

2.3.3.3 Agricultural insurance

While compensation policies are used as a quick response to prevent the spread of diseases, agricultural insurance is a solution to actively deal with agricultural risks to protect farmers against crop and animal loss. In fact, Vietnam had an agricultural insurance service but it has not been very successful due to the lack of mechanisms to promote mutual insurance schemes in this sector (Ha & Tai, 2014). In 2011, the government launched a three-year agricultural insurance trial program. In this period, about 60 thousand animal farms bought agriculture insurance, of those, 94% were poor and nearly poor households. The government paid 100% or 80% of the premium for these farms respectively. In 2018, the Prime Minister promulgated Decree No. 58/2018/ND-CP to stipulate agricultural insurance. According to this document, regarding animal production, agriculture insurance would cover events of natural disasters and epidemics in animals and humans that were declared or confirmed by a regulatory agency. Another policy was issued in June 2019 stating that farms cultivating rice, cow, buffalo, black tiger shrimp and white leg shrimp would receive support with the agriculture insurance fees. Pig and poultry farms were still not mentioned in this current supporting policy. Until recently, the agricultural insurance program was assessed to still be in a standoff due to the issue of costs and benefits (Vietnamnews, 2019). To be more specific, farmers need decent compensation and prefer low insurance premiums with quick and simple procedures, while in contrast, insurance businesses aim to make profits by collecting

high premiums and offering low compensation. Consequently, farmers are not inclined to purchase insurance for their farms.

2.3.4 Regulations on antibiotic usage as feed additives and medicines

Generally, before 2001, ABs were considered as feed additives which were mainly used for growth promotion and against bacterial infections in food-animal production. In Decree 15-CP issued in 1996, ABs were admitted as one of the components in concentrated feeds containing high nutritional substances. Furthermore, the presence of chlortetracycline in feed products, which were approved for importing into Vietnam, was still certified as having a role in ‘improving the use of trace minerals and vitamins’, ‘increasing antibodies’ in animals, and against "gram-negative bacteria" (Decision-55/2001/QĐ-BNN-KNKL, 2001).

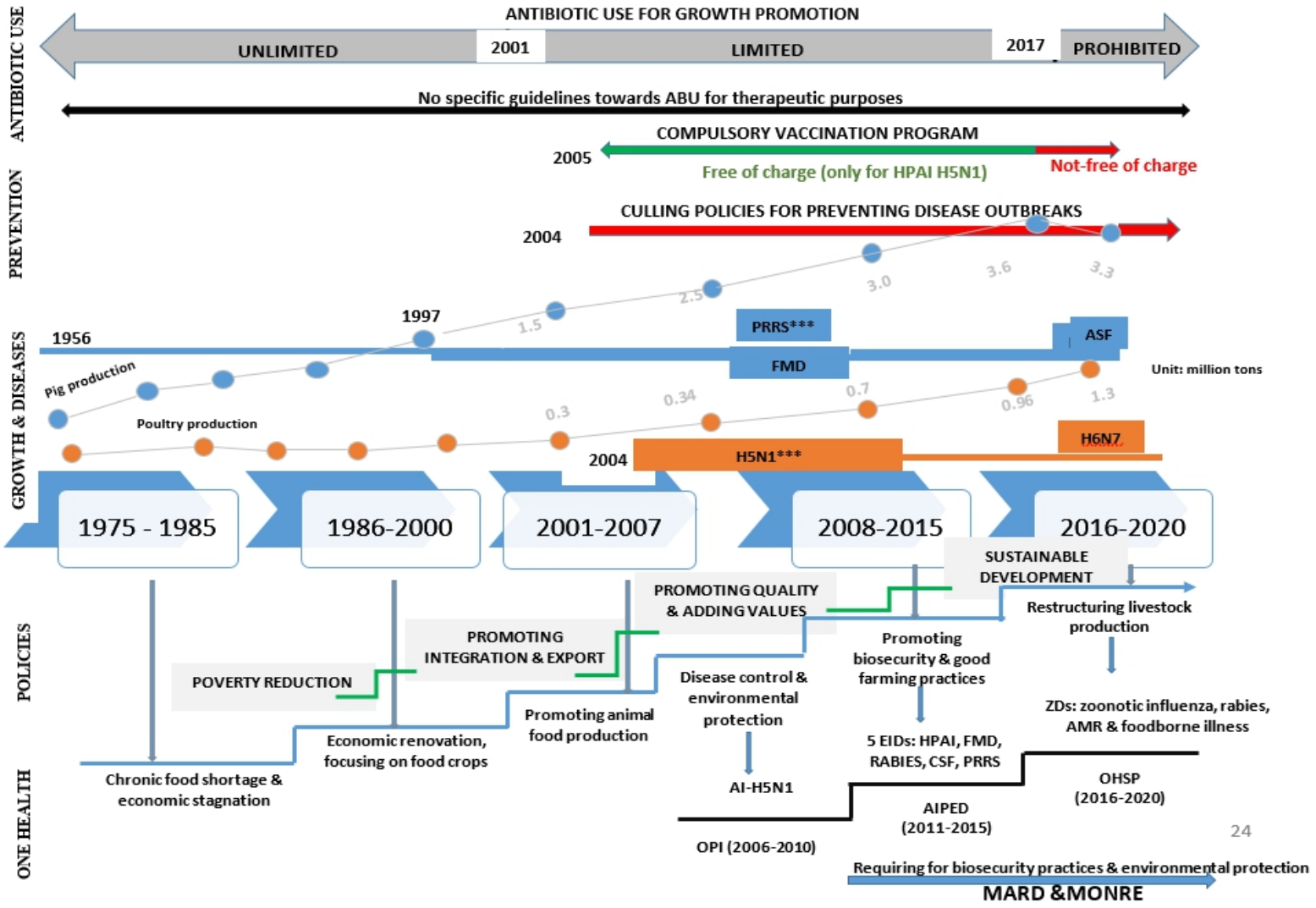
However, also in 2001, chloramphenicol was the first AB prohibited for use in aquaculture in response to requirements of export markets for drug residues in food-animal products (Decretive-07/2001/CT-BTS, 2001). One year later, MARD issued a list of prohibited drugs used as feed additives, in which there were four ABs, namely Chloramphenicol, Furazolidone and Nitrofuran derivatives, and Metronidazole (Decision-54/2002/QĐ-BNN, 2002). In 2009, the list was expanded to fourteen banned ABs (Circular-15/2009/TT-BNN, 2009). The period between 2010 and 2016 witnessed a regular revision of the list, with an addition, a withdrawal or a transfer some ABs from the prohibited list to limited-use list for circulation in animal production. The four-year period between 2016 and 2020 witnessed efforts from policymakers to stop the use of ABs for growth promotion to combat ABR. Vietnam commenced control of ABU as feed additives in 2016 with the restriction of ABU for growth promotion. The Circular 06/2016/TT-BNNPTNT, issued by MARD, provided a list of permissible ABs that could be used as growth promoters. All

commercial feed containing ABs not on this list were forced to stop circulation after December 31st 2016. This deadline was then postponed until June 30th 2017 (Circular36/2016/TT-BNNPTNT, 2016). Also in June 2017, MARD issued decision number 2625/QD-BNN-TY to propose action plans for ABU management and ABR prevention in animal husbandry and aquaculture in the period from 2017 to 2020.

With regards to the presence of ABs as feed additives, this plan shows two actions. They include gradually eliminating and eventually prohibiting the use of Abs for animal growth stimulation, and formulating documents for the restriction and eventual prohibition of ABU for disease prevention in animals. While action one has been detailed in Decree 39/2017/ND-CP and Decree 100/2017/ ND-CP, action two is still in progress. In 2018, the Law of Animal Husbandry, article 12, stated that the use of ABs in feed to stimulate growth, and ABs contained in feed which were not veterinary drugs permitted for circulation, were strictly prohibited acts in animal husbandry. In 2020, according to Decree No. 13/2020, Vietnam has completely stopped the use of ABs as feed additives for growth stimulation. Antibiotic-containing feed for young animals is only permissible to be used for disease prevention.

Efforts to reduce ABU in agriculture are in line with the One Health Strategic Plan (OHSP, 2016-2020). In this plan, ABR and foodborne illnesses are defined as zoonoses, which require cooperation between human medicine and the veterinary sector in developing an integrated framework, overlying and linking the various extent and planned programs and activities aimed at addressing zoonotic diseases, monitoring ABU and ABR in the healthcare, animal, and aquaculture sectors (MARD & MOH, 2016).

Figure 2.4 Mapping major issues and relevant policies in animal production in Vietnam (1975-2020)



In brief, policies on ABU in livestock production in Vietnam went through three main periods, from unrestricted use to limited use and then banned for growth promotion purposes. If ABs were allowed as substances for stimulating food animal production before 2001, it was gradually limited after several shrimp consignments exported to the EU in September 2001 were returned to Vietnam after being detected to contain chloramphenicol. Since then, a list of prohibited or limited ABs for use in food animal production was introduced and expanded until 2016 when only 15 types of ABs were permitted to be used with certain volumes and purposes.

In two Ordinances on Veterinary Medicine issued in 1993 and 2004 and a Law on Veterinary Medicine in 2015, there was a consistent regulation that veterinary drugs must be used according to the instructions of veterinary agencies or the prescription of veterinarians. The Law on Veterinary medicine in 2015 added another regulation that veterinary drugs must be used according to directions for use from drug producers. It is noted that these regulations are for general management of ABU on farms, regardless of farming scale. However, there is still a lack of guidelines for ABU in animal husbandry which was confirmed in the National Action Plan on ABU management and ABR prevention, issued by MARD in 2017. Until recently, MARD has issued the law document for regulating the responsibilities of farmers, veterinarians and drug sellers in drug dispensing with prescription, taking effects from the end of December 2020 (Circular-12/2020/TT-BNNPTNT, 2020)

2.4 Discussions

This is an overview of the livestock sector in Vietnam. I highlighted the significant position of smallholder farmers, including their contributions and the challenges that they are facing. Smallholder farms account for 70% of the total farms in the country, contribute to more than 30% of the total production, and provide employment and income for more than seven million households, especially in the rural areas (GSO, 2016a, 2019). Keeping animals provides income for many rural households (N. T. D. Nga *et al.*, 2014). However, these farmers also show their poor capability in implementing appropriate waste management, hygiene application and animal disease prevention, leading to their vulnerability if outbreaks of animal diseases occur. Although the plan for restructuring the livestock sector, aiming to gradually shift smallholder farms to commercial farms has been proposed since 2008, the continued dominance of this farm scale shows that this plan has not yet been successful.

At the same time, the regulations to monitor biosecurity practices, environmental protection and animal diseases applying to smallholder farms were less strict than those applying to large-scale or industrial farms. I questioned whether smallholder farms were not the main target for improving biosecurity practices due to their poor capability, or whether the veterinary agencies not have enough staff to monitor farming practices of these farms at local levels; or whether law makers not have confidence that smallholders can meet the standards of biosecurity practices. The discrimination between small and large farms can unintentionally destroy smallholder farmers' motivation to change. Consequently, they may continue to conduct unsafe practices and to be vulnerable to environmental degradation and epidemics, and to be a burden for

financial support for the prevention of the spread of animal diseases. Actually, although smallholder farmers are beneficiaries of compensation policies, the compensation rate is not enough for their recovery. Vaccination is not free anymore, so it may increase their production costs. Meanwhile, smallholder farmers prefer not to participate in agricultural insurance and have to actively respond to risks. This context may make them susceptible to more challenges, and may partly explain the reason why they utilize ABs as a means of protecting their production.

Regarding the issue of ABU for food-animals, current policies still leave open the possibility for smallholder farmers to use ABs without a prescription. Moreover, there were not any specific guidelines to monitor ABU on private farms. The current policies to reduce ABU in food-animals do not directly target smallholder farmers. It could be the volume of ABU on small farms was much smaller than that on large farms due to less number of animals on farms. However, the volume of ABs used on all small farms, which accounts for 70% of total farms, could be significant. Furthermore, lessons from Denmark show that efforts to reduce ABU could harm smallholder farmers when, after 20 years, the number of smallholder farmers was reduced by more than 90% (section 1.1). It raises the question of whether smallholder farmers should be engaged in efforts to reduce ABU when their interests could be influenced by ABU reduction (Toebes, 2015).

Chapter 3

AN OVERVIEW OF LITERATURE AND THEORY

3.1 Theoretical approach

Antibiotic resistance (ABR) has historically been considered an issue belonging to technological and biomedical realms; thus, solutions for tackling ABR have mainly focused on technological developments, such as diagnostic or clinical testing (Baker *et al.*, 2018). However, recently ABR has been considered a social rather than biological problem since it is related to the human behaviour of making decision and using ABs (Smith, 2015). Tackling this social problem requires social solutions which are "*based on a greater understanding, measurement, modelling, and ultimately (re)shaping the social, political, and economic environment in which resistance develops and ABs are used*" (Smith, 2015). Although social scientists are well equipped to be involved in ABR research to address the socio-cultural, economic, and political dimensions of this problem, social science research on ABR still remains sparse and widely scattered and lacks input to suggest courses of action that should subsequently be followed (Brown & Crawford, 2009; Frid-Nielsen *et al.*, 2019; Landecker, 2015). Although the participation of social science in addressing the problem of ABR is behind other disciplines, the existing works have contributed significantly to providing valuable insights in understanding social dimensions of ABR (Brown & Crawford, 2009; Chandler, 2019; Landecker, 2015; Will, 2018; L. D. Willis & Chandler, 2019).

In general, the existing social science studies tend to agree that ABR is exacerbated by the practice of over using ABs, either for human care or for animals (O'neill, 2016).

However, some studies tend not to focus on the role of individuals in this process. In a study focused on the practice of prescribing ABs in primary care, Will (2018) suggested that in order to attain a reduction of AB prescriptions, the focus should go beyond the behaviour of the prescriber. It is just as important to examine healthcare institutions, clinical interactions and health inequalities to clarify the need for ABs among patients. Moreover, ABs should be seen as infrastructure, playing important roles in disease prevention for humans and ensuring productivity in animal production where they could "*shape possibilities and constraints in pathways to health*" (Chandler, 2019). ABU was described as a "quick fix infrastructure" for the breakage health systems and for maintaining productivity in animal production in our modern societies, especially in countries and regions with limited human and animal healthcare systems. There a sole intervention for behaviour changes targeted at user and prescribers may bring limited impact and the approach to address the ABU drivers will be required to bring success in reducing ABU (L. D. Willis & Chandler, 2019). In my opinion, these are very helpful in depicting the social structure of ABR, providing new modes of thinking about ABU with evidence of its drivers globally. This also suggests complex solutions for addressing this problem, mainly aiming to make policy-level changes for improving social structures.

However, the active roles of individuals and the value of behavioural changes seem to be underestimated by the views that making efforts in improving knowledge and attitude of individuals could be a short-term solution (L. D. Willis & Chandler, 2019). Lapinski advocates the idea that the roots of all issues and responses lie in the understanding of human actions and interactions (Lapinski *et al.*, 2015). Although

knowledge and information do not drive behaviour directly (M. P. Kelly & Barker, 2016), exploring the current limitations of knowledge could tailor intervention solutions to increase public awareness, skills, and motivation to seek change (Arlinghaus & Johnston, 2017). Moreover, individual and structural changes cannot be considered separately because the ultimate aim of any structural change is to offer favourable circumstances for promoting behavioural changes, and *vice versa* (Gelius & Rütten, 2017)

While public health is calling for urgent action to combat ABR, focusing on public understanding is beneficial to understand whether the public "*share in the sense of awareness, responsibility and urgency*" (Wood, 2016). Literature provides evidence to show that misunderstanding, lack of knowledge or experiences could prevent individuals from following appropriate practices or sharing the same concerns as public health. An anthropological study in the Philippines showed that fishermen and farmers believed that the anti-tuberculosis drug, isoniazid, was a *"vitamin for the lungs",* resulting in the common belief that the medication was useful for weak lungs and promoted self-treatment (Nichter, 1994). Most farmers in a study in Malaysia asserted that ABs should be used for all kinds of sickness in animals, showing their misconception about the conditions requiring ABs and resulting in inappropriate ABU (Sadiq *et al.*, 2018). In another study, when farmers and their neighbours did not have experience of therapeutic failure in animals, they were not concerned about the risks of ABR. Meanwhile, those who had experienced ABR incidences and also positive outcomes from adopting ABU reduction strategies, were more willing to continue with this practice (Visschers *et al.*, 2016). The remaining question is, how aware is the

public of their role in the problem and its solutions (Hawkings *et al.*, 2007). It could be that public knowledge of ABR was still partial and inaccurate due to insufficient information; they did not believe that they play a role in contributing to the development of ABR (McCullough *et al.*, 2016; Whittaker *et al.*, 2019).

Vietnam is still in the early stages of efforts against ABR requiring public understanding and sharing the concern of ABR and how to use ABs prudently. The efforts only started in the medical sector in 2013 and in the animal health sector in 2016 (see Chapter One and Two). The system of policies managing ABU in the livestock sector is still developing and is seeking solutions for monitoring dispensing drugs with a prescription and appropriate ABU on farms (see Chapter Two). Thus, it is too early to evaluate the effectiveness of these policies. However, for behavioural change, comprehensive knowledge of individual behaviours, underlying drivers and influencing factors to stakeholders would be beneficial to both policymakers and the general public, especially in finding appropriate and feasible interventions (Jeffery, 2009). Therefore, the micro-approach could be more suitable since providing an understanding of AB users' existing knowledge, attitudes, and behaviours may be beneficial to policy makers in identifying needs, problems, or barriers. Moreover, interpreting motivations and values that individuals are pursuing could give valuable insights into human nature and suggested pathways to motivate farmers to change and engage in efforts to reduce ABU on farms. The remaining question is, how do we interpret farmers' behaviours and decision making processes on farms? The next section will review theories of decision-making to understand the flow of arguments and suggestions for factors which could influence farmers' decisions and practices.

3.2 Decision-making theories

Decision-making is a process to determine action or inaction from a set of two or more alternatives (McFall, 2015; Turpin & Marais, 2004). Since making decisions is a daily process that individuals perform constantly, there is intrinsic interest in studying and analyzing its features, processes and motives (McFall, 2015). The first theories of decision-making were rational models, such as the Expected value theory, and then the Expected utility theory (Schoemaker, 1982). These initial theories highlighted the role of "*expected value*" which allowed taking into account all the probabilities of possible outcomes if a decision is made. Rational decision-makers were assumed to have all available information, being aware of the probabilities of outcomes, and potential cost or benefits from their decisions (Goldstein & Weber, 1995). Consequently, their choices were optimal, aiming to achieve desirable goals. An important addition to this theory was that personal belief, a measurable variable, affected people when making decisions (Ramsey, 1926). Ramsey argued that the more or less we believed in something would be seen in the final decisions and actions. However, his proposal for measuring belief had received little critical attention until the introduction of Game Theory (Bradley, 2007). Game Theory was introduced in 'The Theory of Games and Economic Behaviour' by John von Neumann and Oskar Morgenstern in the 1940s, and the subsequent addition from the work 'The Foundations of Statistics' (Savage, 1972). The key argument in these theories was that the actions and choices of two or more rational decision-makers affected the outcome of each. Within the context of the game, the players would make a strategic plan, aiming to maximize their payoffs. In the classical game theory, the main approach was an objective probability, which

highlighted the frequency something would happen by observing facts. According to the view of Savage, a decision-maker had a subjective probability opinion about the likelihood outcomes could be obtained. His judgments were based on his beliefs and information about the process (Kadane & Larkey, 1982).

The theories of decisions based on rational models were criticized with the main argument that decision-makers did not always have the complete information available to make rational or optimal choices due to potential limitations of personal and/or external factors (Bourdieu *et al.*, 2000; Schoon & Te Grotenhuis, 2000; Simon, 1997). Herbert Simon suggested the notion of "*bounded rationality*" referring to the inability of decision-makers to calculate probabilities and to process all the uncertain information for the best course of action (Acquisti & Grossklags, 2004; McFall, 2015; Simon, 1957, 1997). This author argued that typical decision-making was a "satisficing" process where an individual made decisions and acted when the minimum requirements were met. Also sharing this viewpoint, Pierre Bourdieu argued that individuals could only make rational choices if "*they have to be in a position to look at their own life in rational terms*". Bourdieu provided an example of poor workers who could not produce economic rationality "*to conceive a plan for his life*", this means that they did not have "*a capacity to methodically and accurately carry out calculation*", which was required for economic rationality (Swedberg, 2011). With regards to the notion of "*economic reason*", Bourdieu stated that in the real world, economic decision-makers came to develop reasonable expectation, not rational expectation (Bourdieu *et al.*, 2000). They usually relied on their experiences and habits to deal with risks and uncertainties (Swedberg, 2011). Furthermore, human behaviour was not only

driven by economic profit, but also by goals, expectations, and values (Glover, 2015). The "*economic only*" view has not been suitable to describe farmers since they had moral beliefs and convictions beyond economic considerations (Meijboom & Stafleu, 2016).

A farmer rarely depended on "*a single category of reasons*" to make decisions and choices (Schoon & Te Grotenhuis, 2000). In reality a wide range of factors were common determinants of farmers' decisions and practices on their farms. Two broad classes of factors were classified as dispositional and environmental factors (James & Hendrickson, 2008; James Jr, 2002). Dispositional factors is a psychological concept referring to attributes within the person such as personality, attitude or belief (Kacmar *et al.*, 2004). In studying farmers' decisions and practices, dispositional or internal factors fall into three groups (McCann *et al.*, 1997). First, socio-demographic attributes refer to an individual's characteristics such as age, level of education or farming experience. Second, farm structure variables are related to farm size, type and income. The third is related to their knowledge and experience. Environmental factors include legislative conditions or law enforcement, market development, physical farm structure, social networks, and natural circumstances (Bourdieu, 1986; Hallam *et al.*, 2012; James & Hendrickson, 2008; Schoon & Te Grotenhuis, 2000). There could be non-enforcement of laws regulating ABU or the high prevalence of infections due to poor hygienic practices (Alhaji & Isola, 2018; Manyi-Loh *et al.*, 2018), the accessibility of ABs mainly through the informal supply chain (Boamah *et al.*, 2016; A. S. Chauhan *et al.*, 2018; Sadiq *et al.*, 2018), limited financial resources to comply with proper ABU

procedures (Friedman *et al.*, 2007), or poor performance of the animal health care system preventing farmers from seeking veterinarian advice (Turkson, 2009). Overall, the theories suggested that farmers could be not economic aiming actors whose practices and choices were influenced by both internal and external factors. Farmers' decisions and practices were not a process driven by only economic motivations. To understand farmers' decision-making, their moral beliefs and values need to be considered too. These motivations, beliefs and values could be results influenced by their external living environment. In other words, internal and external factors which influenced farmers' practices and choices should not be explored in isolation. Farmers' decisions and practices ought to be embedded in their context and in correlation with two broad classes of factors, dispositional and environmental.

3.3 Gaps between scientific knowledge and farmers' understanding about ABU &ABR

3.3.1 Scientists' knowledge of ABU and ABR

Antibiotics (ABs) are commonly defined as medicines used to prevent or treat bacterial infections (WHO, 2018). The modern era of ABs began with the discovery of penicillin in 1928 by Sir Alexander Fleming. Over the next 15 years, ABs not only saved millions of lives from wound infections in World War 2, but also from other fatal infectious diseases (Ligon, 2004). Although clinical problems related to penicillin resistance were already observed, ABs were considered miracle drugs and efforts focused on discovering and developing a number of novel beta-lactam compounds. As a result, the

period between the 1950s and 1970s was a golden age of novel AB discovery when about 18 AB classes were developed during this time (J. Davies, 2006).

In animal production, appropriate use of ABs is expected to treat sick animals caused by bacterial infectious diseases (FAO, 2011). However, looking at the history of ABU in food animal production, the first ABU was for non-treatment purposes. In the late 1940s, New York biochemist Thomas H. Jukes made an accidental discovery while studying vitamin B12 as a supplement for poultry. He found that feed fermented with *Streptomyces aureofaciens* resulted in a dramatic increase in weight and decrease in mortality. Two years later, this discovery was widely adopted in commercial feed production for chicks, piglets and calves with a mix of low dose ABs such as chlortetracycline, oxytetracycline, penicillin, and streptomycin (Kahn, 2016). As a result, livestock production increased, meat became less expensive and intensive farming methods increased. However, the adoption of these new farming methods resulted in a rise in infectious diseases on farms and the demand for ABU to cure or prevent such diseases. Since 1960, the administration of ABs in livestock became common practice with three purposes: growth promotion, therapy and prophylaxis. The highest amount of ABs was seen in animal feed (Kahn, 2016) and just 10% of ABU in animal feed was for treating disease (T. F. Landers *et al.*, 2012; React, 2017). Today, the use of ABs for growth promotion purposes is defined as an unnecessary use and phasing out this practice is required (FAO, 2016b) and ABs must be used in a prudent and medically efficient way (FAO, 2019). Besides that, some common inappropriate ABU is self-medication, using non-prescription ABs, not completing the course, taking

ABs for incorrect indications, taking an insufficient dose, or over dosing (Tangcharoensathien *et al.*, 2018)

Antibiotic resistance (ABR) is when bacteria are able to adapt and grow in the AB containing environment, which means the infected host does not get better during and after treatment with the recommended ABs (FAO, 2016a). Evolution of resistance to ABs is a natural process, but misuse and overuse of ABs in animal farming, such as using the incorrect dose, drug, or course duration in comparison to the indications and directions from manufactures, are recognized as drivers for accelerated acquisition of ABR (OIE, 2015).

3.3.2 Farmers' knowledge of ABU and ABR

Generally, farmers perceive benefits of ABU to their animal production, mainly for curative and preventive purposes, to deal with concerns about infectious diseases which could threaten animal health (Moreno, 2014). Farmers highlighted the benefits of AB administration as being easy to use and quickly effective (Visschers *et al.*, 2015). However, farmers also had limited knowledge about ABs, with regards to proper use and potential links between ABU in farming and resistance in both animals and humans (Kim *et al.*, 2013; Moreno, 2014; Strom *et al.*, 2018; Tangcharoensathien *et al.*, 2018; Thi Kim Chi *et al.*, 2017; Visschers *et al.*, 2015). Moreno (2014) highlighted that some Spanish farmers could not distinguish whether their ABU was for prevention or treatment purposes. Shrimp and fish farmers in Northern Vietnam showed their lack of knowledge about etiological agents when applying specific ABs (Thi Kim Chi *et al.*,

2017). Most farmers in a study in Malaysia asserted that ABs should be used for all kinds of sickness in animals, showing their misconception about the conditions requiring ABs (Sadiq *et al.*, 2018).

With regards to ABR, farmers tended to be neither aware nor worried about ABR, which lowered their motivation to change their behaviour and adopt prudent ABU (Eltayb *et al.*, 2012; Friedman *et al.*, 2007; Marvin *et al.*, 2010; Visschers *et al.*, 2015). Poor awareness of ABR was seen mainly in studies conducted in the low-middle-income-countries (LMICs). In Sudan, three quarters of farmers in one study had never heard about ABR, however, they discussed a relation between drug use and resistance based on their practical experience. Similarly, about half of respondents in another study in Vietnam selected "*unsure/do not know*" when they were asked about ABR (Pham-Duc *et al.*, 2019). In high-income-countries (HICs), farmers tended to have better awareness of ABR but they showed little concern. In a study in South Carolina (USA), farmers showed that they were familiar with ABR and confident with ABU. However, they were not concerned that overuse of ABs in animals could result in ABR among farm workers due to their lack of knowledge about ABR (Friedman *et al.*, 2007). In Sweden, pig farmers showed less concern about ABR than financial issues and infectious diseases, due to less experience with consequences of resistance in both animal and human health. Meanwhile, farmers could easily recognize the consequences of financial and legal changes, which were perceived as more severe to animal husbandry (Visschers *et al.*, 2015). A study in the UK found that vets and farmers felt there was insufficient evidence to prove a decisive link between ABU in food animal production and the development of ABR in either animals or humans. A common belief

among them was that irresponsible use and poor compliance in human medicine were contributing to the ABR problem in human medicine (L. A. Coyne *et al.*, 2014).

In brief, these studies showed that ABs are perceived as being beneficial for food-animal husbandry, however, there is still limited concerns or awareness of the risk of ABR caused by inappropriate use of ABs. Some farmers showed their confidence with the practice of using ABs on livestock farms, but they could not link their practices with the risk of developing ABR, threatening both animal and human health. Poor knowledge of ABU and ABR among farmers was found in both HICs and LMICs. In Vietnam, some relevant studies had the same conclusion that farmers administrated ABs inappropriately or indiscriminately (Carrique-Mas *et al.*, 2015; Kim *et al.*, 2013). Among very few studies focusing on Vietnamese farmers' knowledge, attitudes and practices on ABU, one study concluded that the majority of study farmers self-reported that they had a high level of familiarity with ABs and ABR, at 80.4% and 77%, respectively (Pham-Duc *et al.*, 2019). However, there was a lack of detailed description showing farmers' understanding of these terms. Literature shows evidence that misunderstanding of ABs could influence belief and practice. Thus, local knowledge should be explored to identify existing gaps between scientific knowledge and local understanding and help to explain farmers' habits and practices related to ABU on farms. Although improved knowledge or more favourable attitudes do not always result in better practices (Toral & Slater, 2012); at least, it could be useful in improve farmers' awareness of appropriate ABU. Owing that farmers could share in the concern and responsibility of addressing the ABR problem.

3.4 An approach in this study

The studies I considered generally concluded that there is limited understanding and low concern towards ABR among farmers. However, these studies do not clarify specific gaps between scientific knowledge and farmers' understanding. Although they made efforts to identify factors determining farmers' practices of ABU, various internal and external factors, which were not mentioned in previous studies, were likely to affect farmers' decisions and practices on their farms depending on different farming contexts, the arguments tend to be inconclusive and do not clarify factors determining farmers' choices and practices, including their beliefs and values.

Another limitation of the published works is the methodology applied in exploring farmers' knowledge and practices. They mainly use quantitative approaches for descriptive purposes or purely a Knowledge-Attitude-Practices survey (KAP). The KAP survey is a method which has some limitations (Annika Launiala, 2009). A KAP survey is used to measure knowledge, attitude and practices among people in a specific community to plan activities for behavioural changes. However, behaviour is not only affected by knowledge but also other factors related to cultural-social context, economic, and structural factors. Consequently, information from a KAP survey fails to explain why and when certain practices are chosen as well as the logic behind people's behaviour (A. Launiala & Honkasalo, 2007).

Therefore, this study aims to clarify farmers' perceptions toward ABU, ABR and their decision-making processes related to ABU to identify existing gaps in farmers' knowledge, attitudes and practices in the background of livestock husbandry in Vietnam based on mix-methods of both quantitative and qualitative studies. The

problems addressed in this study are: what do farmers understand and practice about ABU, ABR and the risk to their health from daily activities working on livestock farms, including zoonotic ABR pathogens; which factors influence their practices of ABU; how would farmers respond to the end of antibiotic growth promoters (AGPs) in commercial feed, and what are farmers' motivations and values they are pursuing in livestock farming and ABU.

There are no previous published studies investigating Vietnamese farmers' understanding and motivations related to ABU to seek social intervention solutions to stimulate their commitment with these efforts. Therefore, this study on animal husbandry in Vietnam to explore farmers' perceptions, practices and motivations, can significantly contribute both theoretical and practical insights to the One Health approach to reduce ABU and reduce the development of ABR.

Chapter 4

METHODOLOGY

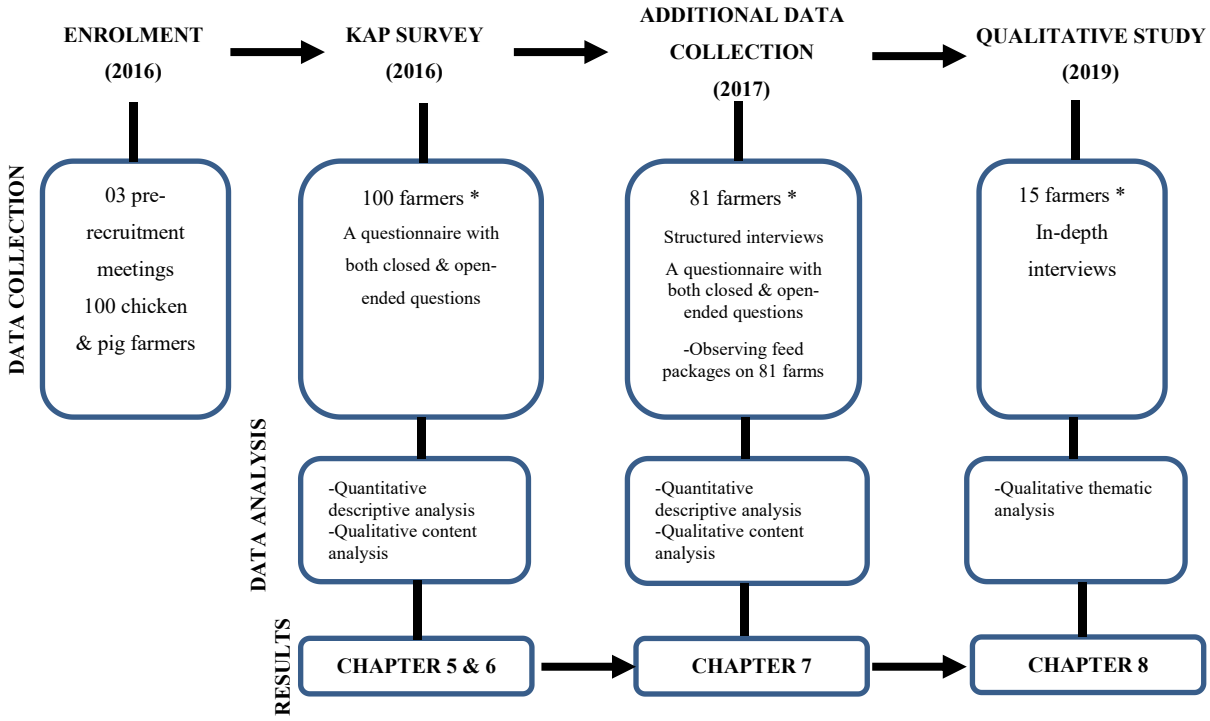
4.1 Overall design

This study focuses on gaining an understanding of what farmers know and the motivations and values they are pursuing in adopting antibiotic usage (ABU) on livestock farms. In this study, a mixed method approach was adopted for both exploratory and explanatory purposes. Three stages of data collection were corresponding with three phases of data analysis during the study period between 2016 and 2019. These were a survey of farmers' knowledge, attitude and practices (KAP) towards ABU, antibiotic resistance (ABR) and zoonotic diseases (ZD) (Appendix A-2), an additional data collection via structured interviews, with both close- and open-ended questions as well as observations about the practices of ABU for sub-therapeutic purposes (Appendix A-3); and qualitative study with mainly in-depth interviews for interpreting farmers' motivations to use antibiotics (ABs) on farms (Appendix A-4). A sample for in-depth interviews, including 15 farmers, was a subset of a cohort of 100 farmers recruited in 2016.

In this chapter, a broad methodological strategy of the study will be set out, from the stage of sampling, recruitment and ethical approval to data collection and analysis. The purpose is to show the flow of the study design as a whole, from quantitative survey to qualitative research for interpreting farmers' motivations and values related to ABU and reduction. The specific methodological aspects such as relevant interview questions and methods for analysis will be reported more detailed in each result chapter. This

setting could be helpful for presenting results of data analysis collected from both closed and open-ended questions (Figure 4.1)

Figure 4.1 Flow chart of quantitative and qualitative data collection and analysis



* All these farmers belonged to a cohort of 100 farmers recruited in the enrolment stage in 2016

4.2 Sampling and recruitment

4.2.1 Calculation for the sample size in KAP survey

The sample size of this study was calculated using Slovin's formula. This formula was introduced by Slovin in 1960 to determine the sample size when there is uncertainty about the population's behaviour (Slovin, 1960).

According to data available from the statistical offices at the study site, there were about 7,000 family farms in total (N=7,000). Subsequently, a 90 percent confidence

level was used to establish the sample size (e=0.1). The sample size was determined to be 100 farms (n), corresponding with 100 farmers who would participate in the study

$$n = \frac{N}{1 + N\,(e)^2}$$

Although several limitations of this formula (e.g. low statistical power and mathematical rigour) have been indicated in literature (Ariola, 2006; Ryan, 2013), it was still adopted by several reasons. First, I wanted a manageable sample size, one which was big enough to build an in-depth understanding and knowledge about farmers and their interactions in the various contexts of livestock farming (Eriksen, 2001). Second, to avoid the possibility of subjective or biased decisions in determining the sample size, I considered confidence levels and margins of error, as suggested by this formula.

I had been considered the KAP survey with only qualitative approach with small sample size to investigate insight farmers' knowledge, attitude and practices towards ABU. However, it was impossible in the first stage of this study because of at least two main reasons. First, this method might be limited in approaching diverse groups of farmers due to time consuming for collecting and analyzing qualitative information (Queirós et al., 2017). Second, the investigator had little knowledge of farmers' issues to appropriately develop in-depth and focused questions in interviews, which could influence data collection and research quality (Anderson, 2010).

4.2.2 Recruitment

A pre-recruitment meeting was organized to introduce the project to the communities and to enroll participants. Four inclusion criteria for recruitment were individuals with primary responsibility for the selected farm and more than 18 years old, obtaining three of more years of farming experience, and giving written consent for participating in activities of the research project.

After the meeting, interested participants who met the inclusion criteria were enrolled. Their demographic and farming information, such as animal type and number of animal heads, was collected (Appendix A-1). A convenience sample approach was used to identify 100 participants with an equal number of pig and chicken farms and an equal number of the different available farm sizes. Informed consent was performed in recruitment.

4.3 Ethical approval

The study was approved by OxTREC (38-15) and the People's Committe of Tien Giang province (2443/UBND-KTN). Permission for recording interviews was not only included in the informed consent form, but also asked directly prior to the interview, where appropriate.

4.4 Data collection and analysis

4.4.1 KAP survey – data collection and analysis

A cross-sectional KAP survey was carried out using pre-designed questionnaire (Appendix A-2) to investigate 100 farmers. Questionnaire content focused on recording

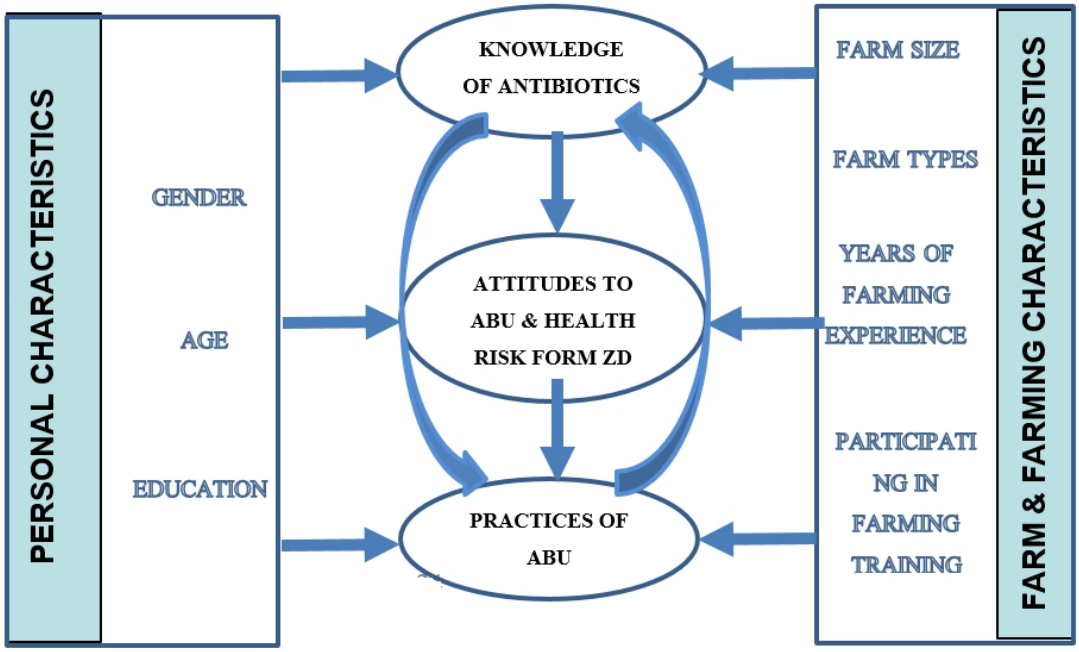
demographic information of farmers and their farming characteristics. Questions were designed to assess their knowledge of ABs, ABU and ABR, zoonotic diseases (ZD), their attitudes towards the necessity of ABU, the risk from ABR and ZD, and their farming practices (including ABU, and preventative solutions for ABR and ZD). Through this assessment, this study aims to identify knowledge gaps, cultural beliefs, and/or behavioural patterns which may facilitate understanding and action, as well as pose problems or create barriers for the efforts of AB reduction in livestock husbandry in the context of Vietnam (WHO, 2008).

The questionnaire was designed to have more in-depth responses and provide a sense of comfort and avoid leading questions (Yaddanapudi & Yaddanapudi, 2019). To achieve this, both open- and closed-ended questions were used, instead of only close-ended questions as other common KAP survey (Appendix A-2). The KAP questionnaire was not ordered with questions for investigating Knowledge, Attitude and Practice. It started with an exploration of daily farming practices with yes-no questions or frequencies. Then, open-ended questions were used to measure farmers' knowledge and attitude mainly in the form of "how" and "why" questions to allow respondents to expand upon answers (Rattray & Jones, 2007). Questions about individual information were in the last section. Each interview with structured questionnaire lasted for between 30 and 45 minutes. In this stage, I did not conduct in-depth interview, because my understanding of farmers at that time was not sufficient for recognizing and expanding questions for interviewing them.

Figure 4.2 shows the analysis plan for data obtained from the KAP survey. Data obtained from the interviews were entered into The CLiRES data management system

(https://clires.oucru.org/), a web application for storing and managing data. Then, it was extracted to MS Excel and SPSS for cleaning, processing and further analysis with descriptive and inferential statistics (Ali & Bhaskar, 2016).

Figure 4.2 Analysis framework for KAP survey



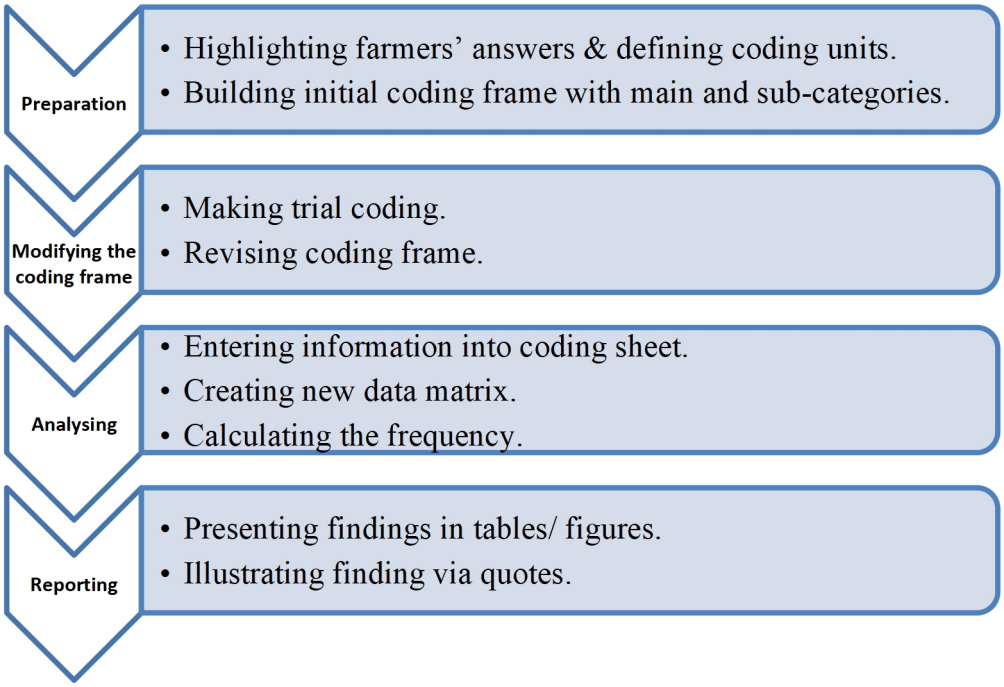
The answers from open-ended questions were analyzed using a content analysis approach (Schreier, 2014). This analysis method was utilized as it allows the researcher to analyze text to obtain insight into social-cognitive and perceptual constructs, which are difficult to study with purely quantitative approaches (Austin & Sutton, 2014). Chapter Five and Six will present more detailed methodology of data collection and analysis.

4.4.2 Additional data collection and analysis

In April 2017, the communities were visited again and individual interviews conducted to further investigate the practice of using antibiotics (ABs) for non-therapeutic

purposes prior to the launch of the National Action Plan for withdrawing growth promoting ABs from feed in early 2018. Among the 100 participants in the KAP survey (Figure 4.1), 81 farmers continued to participate in the structured interviews in this additional study while the remaining 19 farmers did not because they had stopped their farming. The purposes were to explore how farmers were concerned about and behaved towards the presence of ABs in feed and the reasons they added ABs to feed. To collect information, I conducted structured interviews through questionnaire with both closed- and open-ended questions (Appendix A-3).

Figure 4.3: Flowchart for qualitative content analysis



During the interviews, researchers asked farmers to explain further the reasons for their practices, including choice of feed. Information from these conversations was recorded and used for further qualitative content analysis (see figure 4.3). Steps to process closed- and open-ended questions in this stage were to the same as those of the KAP

survey. Chapter Seven will focus on the results of this additional survey. The specific questions and methods for data analysis would also be shown in this chapter.

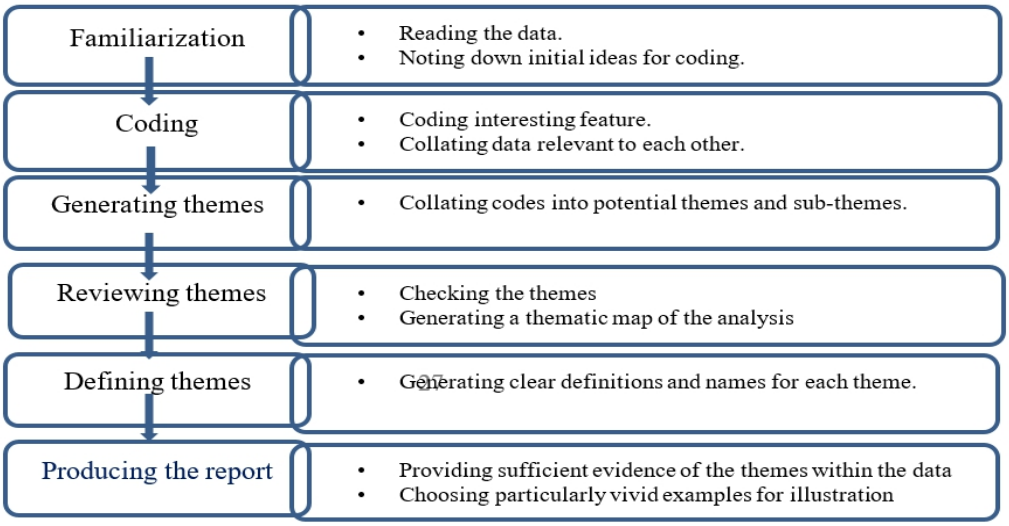
4.4.3 In-depth interview design, data collection and analysis

In-depth interviews were conducted in March 2019 to collect qualitative data to capture farmers' motivations, morals and values related to ABU and reduction. Fifteen farmers invited to participate in the in-depth interviews with purposive sampling method were the participants in the KAP survey in 2016. They were representatives of one of the groups of farmers owning different intentions towards ABU and reduction, after the analysis of the KAP data (for more details see in Section 8.2). Their all profiles related to knowledge, attitude and practices related to ABU on farms were kept as background for understand their motivations. The study design also considered the balance of gender, education, farm size and farm types during the recruitment process for the qualitative study to avoid the potential bias due to the unbalance of these matters; however, the most important factor was whether potential participants were willing to speak about their experiences.

Using a purposive sampling method, farmers who were very active and willing to share their opinions and ideas were invited. With this sampling method, the potential response bias might occur when other farmers who did not want to share might have different motivations. Consequently, this study could not cover all possible thoughts and motives of these farmers towards their ABU practices. I acknowledged this limitation, however, it was inevitable in the first exploratory study. The 'silent" farmers could be approached possibly in the next study.

A semi-structured in-depth interview guide included probing questions focused on farmers' perception of the farming landscape, their farming goals, their common beliefs about animal production, their experiences of ABU, and their concerns and considerations of ABR (Appendix A-4). Each interview was more than two hours in total on different days depending on when farmers were available and felt comfortable.

Figure 4.5: Flowchart for qualitative thematic analysis



To process qualitative data, all interviews were recorded and transcribed in Vietnamese. Qualitative thematic analysis was used to analyze this qualitative information (Braun & Clarke, 2006). The transcripts and notes were arranged into different categories with codes and themes to generate the outcomes and findings of the study (Figure 4.5). In the reporting stage, some pertinent quotes were compiled to aid qualitative analyses within and between relevant groups. Tables or figures are also used to show coding frequencies.

Chapter 5

FACTORS INFLUENCING FARMERS' PERCEPTION AND PRACTICES TOWARD ANTIBIOTIC USE AND RESISTANCE

5.1 Introduction

The Vietnamese government has made efforts to control antibiotic use (ABU) and monitor antibiotic resistance (ABR) in livestock husbandry (Circular36/2016/TT-BNNPTNT, 2016). However, these efforts could be challenged by small scale production and the common use of antibiotics in animal husbandry to deal with high incidence of consecutive epidemic surges and transmission of infectious diseases (Nga *et al.*, 2019). The question is how to engage smallholder farmers in these efforts to reduce ABU and fight ABR without causing harm to their production as the lesson learnt from the EU (see Chapter One). However, we still have a poor understanding of their perceptions of ABU and ABR and their reasons for ABU practices for animals. This study was conducted to characterize smallholder farmers' knowledge, attitudes and practices towards ABU and ABR and the factors influencing their practice of ABU for food-animals. This would be one of the important contributions to implementing feasible intervention strategies and to support the enforcement of AB surveillance and stewardship in Vietnam.

5.2 Methods of data analysis

To achieve the study's aims, structured interviews were carried out with farmer respondents (n = 100) who all gave informed consent, using a pre-designed

questionnaire to collect data. The questionnaire was designed to meet research objectives, tested and modified prior to implementation (Appendix A-2). The questionnaire included a set of both closed- and open-ended questions covering various topics including farm characteristics; knowledge of ABU and ABR; practices of ABU and information sources for using ABs; the intention to apply alternative methods for reducing ABU; and socio-demographic characteristics of participants. The questionnaire forms were labelled with the unique ID number of each farmer. No participants saw the questionnaire form. The interviewer asked the questions and selected the included answer option according to the farmer's answer.

To analyze farmers' understanding of ABU and ABR, farmers' statements defining AB drugs, its functions, ABR and the causes were examined. Statements were categorized into different groups according to content and compared with facts published by WHO, FAO and OIE about ABU and ABR as references to assess participants' understanding and classify them into favorable, moderate or unfavourable understanding of each ABU and ABR (FAO, 2016a; OIE, 2016; WHO, 2015c). ABs were commonly defined as medicines used to prevent or treat bacterial infections (WHO, 2018). In animal production, appropriate use of ABs is for treating sick animals caused by bacterial infectious diseases (FAO, 2011). If farmers only stated that ABU was for preventing diseases, without mentioning the presence of a clinical sign in a herd, or growth promotion in healthy animals, their knowledge was classified as moderate or unfavourable, respectively. The use of ABs for both prophylaxis, without any clinical sign in the herd, and growth promotion was inappropriate because this practice was known to foster resistant emergence (FAO, 2016a). ABR is when bacteria are able to

adapt and grow in the antibiotic-containing environment, which means the infected host does not get better during and after treatment with the recommended antibiotics (ABs) (FAO, 2016a). Misuse and overuse of ABs in animal farming, such as using the wrong dose, wrong drug, and wrong duration of course in comparison to the indications and directions from manufactures, were recognized as drivers for acquisition of ABR (OIE, 2015). Farmers were identified as having favourable knowledge of ABR if they showed their understanding was compatible with the description above. Moderate or unfavourable knowledge groups were those having insufficient or not mentioning any information as stated above, respectively.

Table 5.1: Facts about Antibiotics, use and resistance in animal health sector

	Facts
Antibiotics	Medicines used to prevent and treat bacterial infections (WHO, 2018)
Antibiotic usage	For treating sick animals caused by bacterial infectious diseases (FAO, 2011)
Antibiotic resistance	When bacteria are able to adapt and grow in the antibiotic-containing environment (FAO, 2016a) Drivers for acquisition of ABR: misuse and overuse of ABs in animal farming; and the use of antibiotics for both prophylaxis, without any clinical sign in the herd, and growth promotion (FAO, 2016a; OIE, 2015)

To assess the practice of using ABs on farms (ABP), this study was based on the fact that ABs are used in food animal production for two main purposes: therapeutic and non-therapeutic. For therapeutic purposes, classified as therapy or disease prophylaxis, ABs were used for treating diseased individuals or groups, which might include some animals that were not yet sick or were sub-clinical. For non-therapeutic purposes,

classified as disease prevention or growth promotion, ABs were used for healthy animals for routine prevention or promoting feed efficiency (McEwen & Fedorka-Cray, 2002). Both Food and Agriculture Organization (FAO) and World Organization for Animal health (OIE) encouraged the prudent use of ABs in animal production, including promoting good farming practices, reducing the need for ABs and supporting an end to ABU for non-therapeutic purposes (FAO, 2016b; OIE, 2016).

Generalized linear models were built to investigate potential risk factors associated with the following three outcomes: farmers' knowledge of ABU and ABR, and their practice of using ABs for animals (ABP). The 'ABP' on 4 farms was not identified, therefore, 96 farms were included in the analyses for the outcome of ABP. To analysis, a total of 15 variables were first tested in the univariate analyses (Table 5.2).

Table 5.2 Fifteen variables used in quantitative analysis

Factors	Variables
Farm' s characteristics	Types of animals on farms (chicken or pig
	Farming scale
Farmers' demographic information	Age
	Gender
	Education level
	Farming experience
	Training participation
Farmers' understanding levels	ABU
	ABR
Farmers' attitude	The necessity of ABU
	The intention to adopt AB alternatives
Farmers' practices of ABU	Reasons for ABU
	Self-adjusting the dose
	Reducing dosage of ABU
	Increasing dosage of ABU

Variables were considered as a candidate for multivariate analysis based on their plausibility and a P-value <0.05 in the univariate analyses. Candidate variables were

ranked by their degree of significance and were included in the models starting with the most significant and using a stepwise forward approach. In the final multivariate models, variables were retained if their P-value was <0.05. All interactions between all significant variables in the model were assessed.

5.3 Results

5.3.1 Characteristics of farms and farmers

Table 5.3 Participants' and farms' characteristics, divided by types of animals

Items	Types of farms		
	Total (n=100)	Chicken (n=53)	Pig (n=47)
DEMOGRAPHICS			
Gender	100	53	43
Female	35	14 (26.4%)	21 (44.7%)
Male	65	39 (73.6%)	26 (55.3%)
Age (median, (IQR))	49 (39, 55)	47 (36, 54)	49 (40, 56)
<=40	29	17 (32.1%)	12 (25.5%)
>40	71	36 (67.9%)	35 (74.5%)
Education	100	53	47
Secondary& above	77	43 (81.1%)	34 (72.3%)
Primary	23	10 (18.9%)	13 (27.7%)
FARMING CHARACTERISTICS			
Year of experience (median, IQR))	10 (5,15)	7 (5,13)	12 (9,20)
3-6 years	31	25 (47.2%)	6 (12.8%)
>=7 years	69	28 (52.8%)	41 (87.2%)
Training event participation	2 (1,5)	3 (0,4)	2 (1,5)
n>=2	65	36 (67.9%)	29 (67.1%)
n<2	35	17 (32.1%)	18 (38.3%)
Farming scale *			
Household size (<500 chickens or <50 pigs)	19	12 (22.6%)	7 (14.9%)
Small size (< 5000 chickens or <100 pigs)	44	26 (49.1%)	18 (38.3%)
Medium size (<20,000 chickens or <1,000 pigs)	37	15 (28.3%)	22 (46.8%)

* The farming scale was defined in the Decision of People's Committee of Tien Giang province, number 33/2016/QĐ-UBND

Amongst 100 participants recruited in this study, 53 and 47 were identified themselves as chicken and pig farmers, respectively. The participants were mainly male (65%), more than 40 years old (71%), having educational level from secondary school or above (77%), and having more than seven years of farming experience (69%).

The majority of them owned small or medium size commercial farms (44% and 37% respectively). About two thirds of the study farmers (65%) had a chance to take part in the training events organized by either local department of animal health and husbandry or vet drug companies at least two times during the last year.

There were differences in characteristics of chicken and pig farmers participating in this study (Table 5.3). Chicken farmers were dominated with male farmers (73.6%), while there were equivalent number of male and female pig farmers (44.7% and 55.3%). Median age of chicken farmers was 47, while that of pig farmers was 49. There were more pig farmers (13, 27.7%) had primary educational level than chicken farmers (10, 18.9%). The number of pig farmers (41,87.2%) having more than seven years of farming experience was statistically significantly higher than those of chicken farmers (28, 52.8%) (p-value=0.001).

5.3.2 Farmers' limited knowledge of ABU & ABR

5.3.2.1 Limited knowledge of ABU

Among one hundred farmers in this study, eighteen farmers (18%) could not give their definition of ABs. Amongst those who could, the majority defined ABs as substances "for treatment and prevention of animal diseases" (60, 73.2%). Six farmers (7.3%) defined ABs as "health benefit supplements" (so called "thuốc bổ" in Vietnamese) or

"vaccines". Only sixteen farmers (19.5%) mentioned "ABs are drugs to treat infectious diseases caused by bacteria". When being asked about the purposes of ABU, the majority of farmers described ABs were to be used for treatment (91, 91%) and prevention (69, 69%). A small group of farmers (20, 20%) mentioned the use of ABs for growth promotion. Information from the remaining three farmers was missing.

Table 5.4: Farmers' understanding levels towards ABU & ABR

		Types of farms	
	Total (n=100)	Chicken (n=53)	Pig (n=47)
ABU	100 (100%)	53	47
Moderate to good	63	34 (64.1%)	29 (61.7%)
Limited	37	19 (35.8%)	18 (38.3%)
ABR	100	53	47
Moderate to good	76	43 (81.1%)	33 (70.2%)
Limited	24	10 (18.9%)	14 (29.8%)

The answers of the above two questions given by the one hundred farmers interviewed in this study were used to categorize the farmers into favourable, moderate, and unfavourable understanding of ABU. The group with limited knowledge of ABU included thirty-seven farmers (37%) who either could not provide a definition or a description of its effects as well as described the effect of ABs for promoting animal growth. ABs used for treatment or prevention with no specific information on any types of diseases or pathogens were the answers of the majority of farmers (50%) and they were categorized into the ABU moderate knowledge group. Thirteen farmers (13%)

correctly defined ABs and described the purpose of ABU in killing bacteria causing animal diseases were placed in the ABU good knowledge group (Table 5.4).

5.3.2.2 Limited knowledge of ABR

Responding to the question whether they knew about ABR, twenty three farmers (23%) said "no" while the others affirmed that they knew well (24%) or little about this issue (53%). The latter two groups (77 farmers) were asked an additional question to determine their definition of ABR. However, twenty-five (33%) did not provide an answer. Among the fifty-two (67%) that shared their ideas, the majority of farmers (46, 88.5%) defined ABR with their observation of no significant (clinical) improvement in sick animals during and post AB treatment. Another three farmers (5.8%) described their recognition of ABR phenomenon in animals via the slow growth (stunting) characteristics of animals after a few treatments of ABU. Only three remaining farmers (5.8%) described ABR as the consequence of "bacterial adaptation" and/ or "bacterial modification to survive ABU" or of "ineffective treatment for bacterial infections". Answering the question about what was the cause of ABR, amongst 77 farmers, the proportion of farmers providing no reason, less than three reasons and at least three reasons were one (1.4%), 43 (55.8%) and 33 (42.8%), respectively. Their answers were "wrong dose" (58, 75.3%) (using "more" or less than the specific recommended dosage on the drug label), "wrong duration" (53, 68.8%) (using "longer" or "shorter" than the recommended duration), and "incorrect purposes" (41, 53.2%) (using for the prevention of illness in the absence of any clinical symptom or for growth promotion purpose). A few farmers (7, 9.1%) provided other reasons for ABR including "any ABU leads to ABR naturally", "repeated use of the same ABs (for a long period)", "poor cleaning

and disinfection procedure", "the antibiotic was already resisted" and "due to poor drug storage condition". The latest implied the under-dosage of ABs in practice, which could likely lead to little improvement in clinical presentation of sick animals.

The answers for all three questions from all studied farmers were analyzed to tabulate their levels of understanding to ABR. The ABR limited knowledge group included twenty-four farmers (24%) who did not know about ABR or could not provide definition of ABR or any appropriate reason causing ABR. The ABR moderate understanding group included fifty-three farmers (53%) who provided at least one appropriate causative reason for ABR. The ABR good knowledge group included twenty-three farmers (23%) who appropriately defined ABR and provided at least three causative reasons for ABR (Table 5.4).

5.3.3 Common inappropriate practices of ABU

5.3.3.1 The common use of ABs for non-therapeutic purposes

In this study, except for four farmers (4%) who had no idea about ABU because the ABU on their farms was decided by their relatives, the others (96%) reported that they used ABs on animal farms for treatment purposes (89, 89%), for routine prevention (53, 53%) and as growth promoters (12, 12%). Overall, 39 farmers (39%) reported that they used ABs for exclusive treatment purposes, while the remaining (57, 57%) used ABs for both treatment and non-treatment purposes. The latter group of farmers described ABs were used monthly for "routine prevention" for animals with "sub-therapeutic dose" when no animals had any clinical signs of illness. For example, farmers experienced that Avian Pasteurellosis could happen when chickens were at two-months

old; before this disease could occurred, farmers would use some kinds of ABs such as Enrofloxacin or Neomycin, combining with B-complex vitamin C for active prevention. They said they wanted to build up “the resistance” of animals to protect from disease infections. In additions, a few farmers reported that they used ABs for growth promotion (12, 12%), aiming to improve feed efficiency and daily weight gain. This practice of ABU for non-treatment purposes was seen more commonly on chicken farms (33, 64.7%) than on pig farms (24, 53.3%) (Appendix B - Chapter 5 - Table 1).

5.3.3.2 The very common practice of self-adjusting antibiotic dosage

Among 78 farmers who provided answers for the question whether they self-adjusted the AB dosage differently to the instruction printed on the drug labels, up to 60 farmers (76.9%) confirmed that they commonly did. The practice of increasing the drug concentration was more commonly reported (52, 64.2%) than that of reducing the concentration (34, 42%) (Appendix B - Chapter 5 - Table 1). Almost half of these farmers (26, 43.3%) carried out both of these practices. Farmers used higher concentration of AB to “speed up the recovery process” of their sick animals (22, 42.3%), to “treat severely sick animal(s)” (13, 25%) and since they believed that the recommended dose was too low to effectively treat sick animals (17, 32.4%). Reasons given for using a lower the concentration of ABU were to prolong the duration of usage (18, 52.9%), to treat recovering or mildly ill animals (7, 20.5%), for routine prevention (5, 14.7%), and to use in combination with other ABs (4, 11.7%).

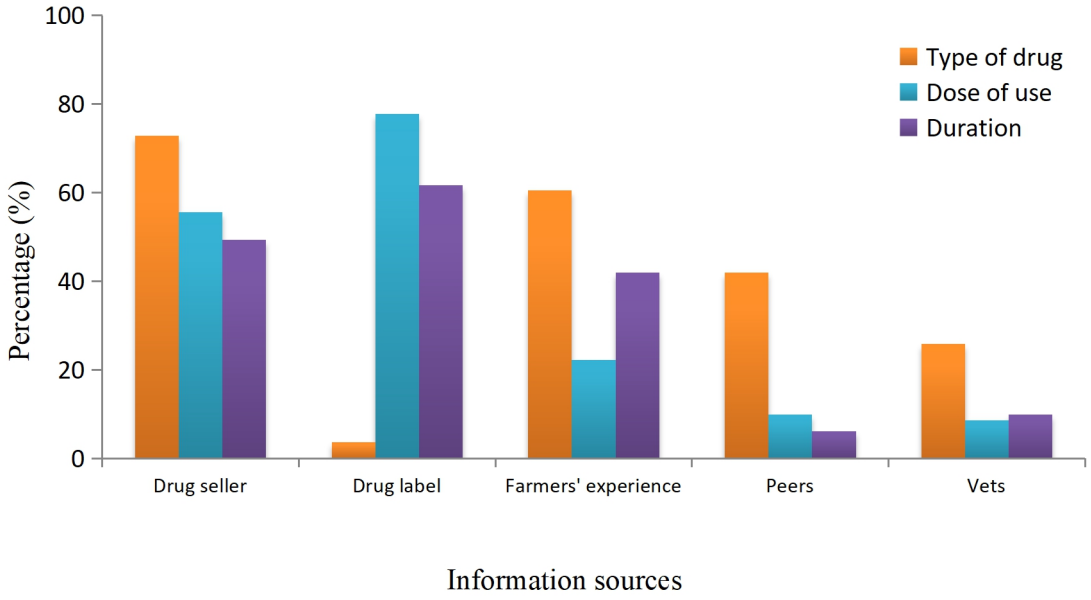
In investigating an association between an understanding of ABU and ABR and the practice of self-adjusting dosage of ABs, data showed that farmers still decided to increase or decrease the dosage of ABU for their animals whether they had a good

understanding of ABU and ABR or not. However, these practices were seen more in those who had a limited understanding of ABU and ABR (Appendix B - Chapter 5 - Table 1).

5.3.4 The common sources used by farmers seeking acquiring ABU advice

We asked farmers what the information sources were that they used to make decisions on ABU including which type of drug to use, its dosage, and duration of use on the farm. Among different sources, local veterinarians were reported as the least common source while three most common were drug sellers, instructions on drug labels, and farmers' own experiences (Figure 5.1). Besides that, our study farmers also reported their participation in training workshops organized by local veterinary departments or vet-drug companies within the previous year.

Figure 5.1 Information sources for ABU



Amongst 81 respondents, data show that only 23 farmers (28.4%) reported veterinarians as their source for drug related information, such as types of drugs (21, 25.4%), dosage (7, 8.6%) and duration (8, 9.9%). Amongst these, ten small-farm farmers (12.3%) and six farmers of medium sized farms (7,4%) used free of charge services from veterinarian-friends, feed-mill or pharmaceutical company associated veterinarians. Besides these free of charge services, five farmers of medium sized farms (6.17%) also mentioned the service of local chargeable veterinarians. However, these farmers also indicated that problem solving based on their own farming experiences would be more economical and trustworthy than the advice of local veterinarians. One farmer said:

> "*Only in the case of an emergency will I call them and consult with them... However, we need to learn to do ourselves, if we always use vet services, how can we get economic profits? ... although local veterinarians have been trained ... they have less practical experience with caring for animals than us*" (A farmer from a medium sized pig farm).

More than half of the study farmers mentioned drug sellers as a source of information for selecting ABs to use (59, 72.8%), dosage (45, 55.6%) and duration (39, 48.2%). Overall, drug labels were the most common source of information for dosage (63, 77.8%) and duration (50, 62.7%) of ABU. Farmer's own experience was the second and third most common source of information for type of ABs (49, 60.5%) and duration of use (34, 42%), respectively. Over 50% (18/34) and 40% (14/35) of farmers with medium and small sized farms, respectively, mentioned peers as a source of

information for type of ABs in comparison to only over 16% (2/12) of household farmers.

With regards to the training workshops, information from the Sub-Department of Animal Health and Husbandry (SDAH) indicated that about 40 training events took place in the study area in the previous year. Of these, 20% were led by SDAH to communicate with farmers about animal diseases or prevention solutions, and the remaining 80% were organized by vet-drug companies for advertisement purposes. Three-quarters of the study farmers (76, 76%) reported their participation in these training events. Sixty-five farmers (65%) took part in at least two training events in the previous year. Of these, more farmers were from small (63.6%) or medium (81.1%) farms rather than household (36.8%) farms. Participants recalled being provided information on farming skills, treatment and prevention of animal diseases, as well as information for drugs and medicine use on farms from animal husbandry or veterinary experts. Farmers preferred to participate in events organized by vet-drug companies because these companies invited experts in veterinary medicine or animal husbandry to give talks and they also offered participants with better training facilities and even gifts as incentives for participation.

5.3.5 Attitudes towards antibiotic reduction: highlighting the necessity of ABU

5.3.5.1 The necessity of ABU in animal husbandry

Only six farmers (6%) said ABs were not necessary. The majority (89, 89%) confirmed that ABU was “necessary” and was a major solution to protect animal health. However,

only 26 farmers (29.2%) of the latter group highlighted the "very necessary" role of ABs to livestock animals, while the other 63 farmers (70.8%) said ABs were necessary but not very necessary in livestock production (Appendix B - Chapter 5 - Table 1). Studied farmers shared that they had not been abusing the use of ABs since they said they were aware of both the benefits and harms of ABU to both economic profits and animal health issues. Qualitative data shows that these farmers repeatedly mentioned "have to use", being "reluctant" to use, or the use of ABs was "unavoidable" for food-animals which suggested that to farmers ABU was "inevitable" in dealing with animal illness in the current rapid development of the livestock sector. They reported their observation that livestock animals had been more susceptible to diseases than previously. However, they were worried about poor animal productivity, slow-growth and ABR as possible consequences of the current increase in ABU. Besides that, farmers also argued that they used ABs with consideration to save production cost. "*If my animals die, I will lose income... If a pandemic occurs, my household will go bankrupt, therefore I have to do everything to prevent that. ABs are not abusively used; only sick animals will be given ABs, drugs are very expensive*" (A farmer from a medium sized pig farm)

5.3.5.2 Farmers' own intentions to reduce ABU on farms

Among 100 farmers, thirty-five said that they had experience in adopting solutions for reducing ABU on their farm. The most common alternatives included using vitamins, probiotics or bio-products, aiming to boost animal immunity (20, 58.8%). The second common alternative approach was to improve hygiene conditions coupled with

selecting appropriate feed and complying with a strict vaccination schedule (7, 20.6%). The third common approach was to use herbs as natural vitamins or for an AB-like effect for regular prevention (4, 11.8%). The remaining farmers (3, 8,8%) combined different aforementioned alternatives for disease prevention.

Among the aforementioned 35 farmers, four farmers reported that their efforts to reduce ABU by increasing farm hygiene, feed and vaccination, using ABs for only treatment was not successful enough to continue. The remaining case, who mainly focused on improving hygiene conditions in the past, confirmed that he would continue his efforts by trying other alternatives for AB reduction.

The remaining 31 farmers saw positive outcomes of alternative solutions, such as "*better growth and better health*" (31 farmers, 100%) and "*saving production cost*" (23, 74.2%). Only six cases (19.4%) mentioned "an increase of selling price" due to an increase of product quality as an achievement of their efforts in reducing ABU. However, four farmers were concerned about production costs and economic efficiency. To be more specific, these farmers were worried that the raising period for each flock might be longer, leading to higher production costs and a lower economic benefit. Therefore, different to the other 27 farmers, these four farmers were not willing to continue to reduce ABU on their farms in the future.

In the end, there were 31 farmers who intended to reduce ABU on their farms. They included 27 farmers who had positive experiences with AB reduction, one farmer who would like to try other alternatives to ABs in spite of his previous unsuccessful experiences, and three farmers who had not tried in the past but intended to try in the future to gain experience.

5.3.6 Factors related to knowledge and practices of ABU and ABR

To identify the factors associated with a limited knowledge of ABU and ABR, and the practice of ABU for non-therapeutic purposes, several factors related to demographics (gender, age, education, training event participation), farm characteristics (farming scale, type of animals (chicken or pig farms), knowledge, attitudes and practices of farmers were analyzed (Table 5.5). Not having the intention to reduce ABU was the only significantly associated factor to those having limited knowledge of ABR [OR 4.59, 95% CI (1.16-18.1)]. And, there was no factor identified to significantly associate with limited knowledge of ABU. Several factors were identified via univariate analysis to associate with limited knowledge of ABU and ABR but did not remain significance in multivariate analysis, except for attending too few local training courses (up to two) [OR 2.1, 95% CI (0.7-6.0)].

Table 5.5: Results from univariate analysis

Item	Limited understanding of ABU				Limited understanding of ABR				ABP for non-treatment purposes			
	No. part	Uni-variable analysis			No. part	Uni-variable analysis			No. part	Uni-variable analysis		
		OR	95% CI	p value		OR	95% CI	p value		OR	95% CI	p value
DEMOGRAPHICS												
Gender												
Female	18/35	2.56	**1.09-6.00**	**0.03**	15/35	4.66	1.76-12.3	**0.03**	19/32	1	0.42-2.37	1
Male	19/65	Ref			9/65	Ref			38/64	Ref		
Age												
<=40	12/29	Ref			5/29	Ref			19/28	Ref		
>40	25/71	0.7	0.318-1.866	0.65	19/71	1.75	0.58-5.25	0.4	38/68	0.6	0.23-1.51	0.3

Education												
Secondary& above	24/77	Ref			15/77	Ref			44/74	Ref		
Primary	13/23	2.8	**1.1-7.4**	**0.04**	9/23	2.65	0.96-7.29	**0.09**	13/22	0,9	0.37-2.59	1
FARMING CHARACTERISTICS												
Year of experience												
3-6 years	12/31	1.1	0.46-2.66	0.8	10/31	1.87	0.72-4.8	0.2	20/29	1.8	0.7-4.5	0.2
>=7 years	25/69	Ref			14/69	Ref			37/67	Ref		
Training event participation												
n>=2	19/65	Ref			14/65	Ref			41/63	1.98	0.79-5.0	0.15
n<2	18/35	2.56	1.09 – 6.01	**0.03**	10/35	1.42	0.56-3.73	0.47	16/33	Ref		
Training event participation												
Yes	25/76	Ref			9/24	Ref			10/22	Ref		
No	12/24	2.04	0.8-5.2	0.15	15/76	2.44	0.89-6.64	**0.1**	47/74	0.4	0.18-1.25	0.14
Farming scale												
Small size	28/63	2.48	1.01-6.12	**0.05**	16/63	1.23	0.46-3.24	0.8	39/59	2.05	0.88-4.76	0.13
Medium size	9/37	Ref			8/37	Ref			18/37	Ref		
Types of animals												
Chicken	19/53	Ref			10/53	Ref			33/51	Ref		
Pig	18/47	1.11	0.4-2.5	0.8	14/47	1.82	0.72-4.62	0.2	24/45	0.6	0.27-1.41	0.3
KNOWLEDGE												
ABU												
Moderate to good					10/63	Ref			33/62	Ref		
Poor					14/37	3.2	1.25-8.32	**0.016**	24/34	2.1	0.86-5.13	0.13
ABR												
Moderate to good	23/76	Ref							42/74	Ref		

Poor	14/24	**3.2**	**1.25-8.3**	**0.016**					15/22	1.63	0.59-4.47	0.45
ATTITUDES												
Assessing antibiotic need												
Very necessary	6/26	Ref			9/26	Ref			39/69	Ref		
Not very necessary	28/69	2.27	0.81-6.38	0.15	13/69	0.43	0.16-1.20	0.17	17/26	0.68	0.26-1.75	0.48
Intention of reducing ABU												
No	26/69	1.1	0.45-2.65	1	21/69	4.08	1.11-14.9	**0.025**	44/65	2.9	1.2-7.0	**0.026**
Yes	11/31	Ref			3/31	Ref			13/31	Ref		
PRACTICES												
Reasons for ABP												
For only therapeutic purposes	10/39	Ref			7/39	Ref						
For non-therapeutic purposes	24/57	2.1	**0.86-5.13**	0.13	15/57	1.63	0.59-4.47	0.45				
Self-increasing dosage of ABU												
Yes	18/52	0.84	0.32-2.25	0.8	6/26	1	0.32-3.05	1	14/24	1.2	0.4-3.3	0.8
No	10/26	Ref			12/52	Ref			33/52	Ref		
Self-decreasing dosage of ABU												
Yes	**17/34**	**3**	**1.15-7.81**	**0.03**	12/34	3.45	1.13-10.5	**0.03**	23/32	2.7	1.01-7.40	**0.05**
No	**11/44**	**Ref**			6/44	Ref			23/44	Ref		
Self-adjusting dosage of ABU												
Yes	23/60	1.6	0.51-5.13	0.57	15/60	1.67	0.42-6.56	0.5	39/58	2.5	0.8-7.5	0.1
No	5/18	Ref			3/18	Ref			8/18	Ref		

Regarding the practice of ABU, our data suggested that those attending two or more local training courses [OR 4.1, 95% CI (1.2-14.4)]; having small size farms [OR 4.2, 95% CI (1.3-13.6)]; not intending to reduce ABU in farming practices [(OR 3.5, 95% CI (1.12-109)]; and practicing reducing the dosage of ABs [OR 5.6, 95% CI (1.6-18.7)] were significantly associated with the practice of ABU for non-therapeutic purposes (Table 5.5 and 5.6).

Table 5.6: Results from multivariate analysis

Item	Limited understanding of ABU				Limited understanding of ABR				ABU for non-treatment purposes			
	No. part %	Multi-variable analysis			No. part %	Multi-variable analysis			No. part %	Multi-variable analysis		
		OR	95% CI	p value		OR	95% CI	p value		OR	95% CI	p value
DEMOGRAPHICS												
Gender												
Female	18/35	2.2	0.9-5.5	0.07	15/35	3.7	1.3-10.2	**0.01**	19/32	0.9	0.3-2.1	0.8
Male	19/65	Ref			9/65		Ref		38/64			
Education												
Secondary& above	24/77	Ref			15/77	Ref			44/74	Ref		
Primary	13/23	2.4	0.9-6.6	0.07	9/23	1.7	0.5-5.3	0.32	13/22	0.8	0.2-2.2	0.6
Year of experience												
3-6 years	12/31	1.1	0.46-3.05	0.7	10/31	3.0	0.9-9.2	0.05	20/29	1.6	0.6-4.3	0.3
>=7 years	25/69	Ref			14/69	Ref			37/67	Ref		
FARMING CHARACTERISTICS												
Training event participation												

n>=2	19/65	Ref			14/65				41/63	4.1	1.2-14.4	**0.026**
n<2	18/35	2.1	0.73-6.00	**0.1**	10/35				16/33	Ref		
Farming scale												
Small size	28/63	1.53	0.53-4.39	0.4	16/63				39/59	4.2	1.3-13.6	**0.015**
Medium size	9/37	Ref			8/37				18/37	Ref		
Type of animals												
Chicken	19/53	Ref			10/53	Ref			33/51	Ref		
Pig	18/47	0.8	0.35-2.04	0.7	14/47	0.3	0.1-1.0	**0.05**	24/45	1.4	0.6-3.3	**0.4**
KNOWLEDGE												
ABU												
Moderate to good					10/63	Ref			33/62	Ref		
Poor					14/37	2.3	0.8-6.5	0.09	24/34	2.3	0.8-5.9	0.08
ATTITUDES												
Assessing antibiotic need												
Very necessary	6/26	Ref										
Not very necessary	28/69	3	0.9-10.3	0.07								
Intention of reducing ABU												
No	26/69				21/69	**4.59**	1.16-18.1	**0.03**	44/65	3.5	1.12-10.9	**0.03**
Yes	11/31				3/31	**Ref**			13/31	Ref		
PRACTICES												
Reasons for using Abs												
For only therapeutic purposes	10/39	Ref										
Therapeutic &	24/5	2.6	0.90-	0.07								

non-therapeutic purposes	7	7.5				
Self-decreasing dosage of ABU						
Yes			23/32	5.6	1.6-18.7	**0.006**
No			23/44	Ref		

5.4 Discussion

With an increase in recognition that ABU in food animal production is an important contributor to human infections with ABR bacteria, the public health sector required actions for reducing the widespread use of non-therapeutic ABs in animals to preserve AB source (Martin *et al.*, 2015; Timothy F. Landers *et al.*, 2012). One of the major recommendations is a requirement of behavioural changes in ABU practices among farmers. However, our understanding of farmers' knowledge of ABU and ABR and their ABU practices is still poor (Speksnijder & Wagenaar, 2018). The aim of this study is to characterize smallholder farmers' knowledge, attitudes and practices towards ABU and ABR to find out feasible solutions for engaging them in efforts to reduce ABU on farms.

The first finding is that the study farmers had limited knowledge of ABU and ABR. A few of them (13%) correctly knew that ABs were used for the treatment of bacterial infections. Generally, they perceived that ABs were drugs to treat or prevent animal diseases, but not specific types of diseases. Some farmers even defined ABs as "health benefit supplements" used to increase antibodies in animals. Consequently, this misunderstanding implied that ABs were harmless and beneficial to animal health and

encouraged them to use ABs indiscriminately. This is similar to the case described in an anthropological study in the Philippines that the anti-tuberculosis drug isoniazid was believed to be a “vitamin for the lungs”, resulting in the common belief among fishermen and farmers that the medication was useful for weak lungs and promoted it for self-treatment (Nichter, 1994). The study result indicated the misconception among lay people, such as farmers, about the conditions requiring ABs (Sadiq *et al.*, 2018). With regard to ABR, farmers had also misunderstood when they said consequences of AB abuse and resistance were related to the low growth or poor productivity of animal production or ineffective treatment courses. This perception implied that the animal body became resistant to ABs, while in fact that was bacteria carrying with animals becoming resistant to certain ABs (WHO, 2018). This finding was in line with a result from a WHO survey in 2015, that 86% of Vietnamese respondents had this misunderstanding, and that this proportion was the highest of the countries included in that survey (WHO, 2015a). It could be seen that farmers’ understanding of ABR mainly relied on their personal experience rather than on scientific facts. Similarly, farmers were also unaware of zoonotic infections that had no impact on them, in comparison to their knowledge of common animal diseases. Warnings that zoonotic bacteria are capable of transferring resistant genes to human bacteria seem to be ignored by farmers (Argudín *et al.*, 2017; Trung *et al.*, 2017).

With regard to ABU practices, data in this study suggested that farmers still conducted inappropriate practices with the common use of non-therapeutic purposes (59.4%) and adjusting the dosage (76.9%) for either treatment or prevention of animal diseases. From their reasons, it could be seen that they utilized ABs as a means of addressing

their concerns of animal diseases, the mistrust of recommended doses by manufactures or the quality of the drugs. Consequently, to deal with animal care and productivity, ABs became a "quick fix" approach (L. D. Willis & Chandler, 2019). Data in this study did not show a significant association between limited knowledge of ABU and ABR and inappropriate ABP. However, data showed no intention to reduce ABU was associated with poor knowledge of ABR and inappropriate ABP. Moreover, literature suggested that poor understanding of ABR could lower farmers' motivation to change their behaviour and adopt prudent ABU (Eltayb *et al.*, 2012; Friedman *et al.*, 2007; Marvin *et al.*, 2010; Visschers *et al.*, 2015). Therefore, providing appropriate and sufficient knowledge of ABU and ABR should be one of the first components for reducing the unnecessary and inappropriate use of ABs (Alarcon *et al.*, 2014).

The levels of participation in the local training events could be an intermediate variable affecting a relationship between knowledge and practice. Results in this study showed that the less farmers participated in training events was associated with the limited knowledge of ABU among farmers; however, the more they participated in these training events (more than two events), the more they adopted the use of ABs for non-therapeutic purposes. This result may suggest that information provided by these training events was not favourable to reduce ABU. It was noticed that the majority of these training events (80%) in the previous year were held by drug companies for marketing or advertisement purposes. To understand the connection between advertisement events and an increase in ABU, we can review the case of tobacco advertising as shown in the literature. Advertisements increased tobacco consumption by encouraging smokers to continue and inducing young people to start smoking

(Roemer & Organization, 1993). Furthermore, when advertisements promoted smoking habits spread in a society, more people took up smoking, and the habit became acceptable (Muller, 1978). Consequently, public health activists had to call for restrictions on the content of tobacco advertising (Saffer & Chaloupka, 1999). Through the case of tobacco above, we cannot deny the potential power leading to a common wrong and harmful practice. Via verbal communication with the study farmers, I learned that commonly the provided information in these trained events was about the effectiveness or benefits of veterinary medicine, including ABs, on preventing disease, treating infections and animal productivities, which could motivate ABU. Meanwhile, AB potential adverse effects were not provided. These will be unfavourable to the efforts to reduce ABU. Nevertheless, these events became a source providing information, knowledge and skills for animal care for farmers via the participation of veterinary specialist speakers. The question is then, how can the content of these training events be managed to make sure that both the effective use and the side effects of drug use be sufficiently conveyed. I believe these training events can be utilized as one of the information sources but the advertisement of ABs should be monitored. With regard to information sources for making decisions about ABU on farms, data indicated that farmers' own experiences played as one of the main information sources. Farmers did not actually comply with directions from the external sources such as recommendation printed in drug labels (77.8%) or vet-drug sellers (55.6%), as they reported, when they implemented self-adjusting dosage of ABU. It was also unsurprising to find that community animal health workers (CAHW) and veterinarians were identified as the least common source for acquiring any information for ABU

dosage (8.6%). Farmers preferred their own experiences to CAHW and veterinarians' consultancies. Farmers seems to think that CAHW and veterinarians may not have sufficient experiences in farming in comparison to theirs.

This situation may imply the possible ineffectiveness of local veterinarians in clinical judgment, disease diagnosis and giving advice on ABU to the local farmers which would negatively impact the national and global effort to control the current curbing of the indiscriminate use of ABs (FAO, 2016b; OIE, 2016). In the EU, veterinarians' advice played an important role in influencing farmers' practices and became one of the key factors contributing to the success of the ban on growth-promoting ABs (Friedman *et al.*, 2007; McDougall *et al.*, 2017). Thus, one of the missions for promoting prudent ABU in Vietnam should be an improvement in the role of local veterinarians in managing ABU on farms.

One limitation was found in this study. That was the analysis based on a combination of pig and chicken farms, although in the initial study design, there was an assumption that the different in animal type could influence farmers' knowledge, attitudes and practices (KAP). However, data showed that it was not any significant associated with farmers' KAP. It could be there was a flexible switch between keeping pigs or chickens or operating mix-farms to adapt the fluctuation of the market. Therefore, the comparison between pig farmers and chicken farmers were not emphasized in the analyses.

To the best of my knowledge, this study could be the first describing the practice of self- adjusting the dosage of ABU among farmers in Vietnam. This practice was also a kind of self-medication, as mentioned in literature (Eltayb *et al.*, 2012; Oluwasile *et al.*,

2014). This issue was highlighted as an important driver of AB overuse, especially in low- and middle-income countries. In Vietnam, self-medication in the human health sector was quite common in both urban (50%) and rural areas (28%) (D. T. T. Nga *et al.*, 2014). When people got sick or had a fever, they treated themselves with ABs without a prescription despite legislation in 2003 that ABs could only be purchased with a medical prescription. The practice of self-prescription was encouraged by the poor enforcement of regulations among drug sellers and their customers. In the animal health sector, although there was a rule since 1993 that veterinary medicine must be used with instructions or prescription of veterinarians, ABs are still dispensed without prescription commonly. Until recently, the responsibilities of farmers, veterinarians and drug sellers in drug dispensing with prescription were regulated by MARD in the circular, which come into force since 25th December 2020 (Circular-12/2020/TT-BNNPTNT, 2020). These facts suggested that it would be a long journey to effectively manage ABU on animal farms and phasing out the habit of self-prescription in Vietnam where both legislation for ABU control and enforcement were still incomplete.

Farmers had a favourable attitude towards reducing the use of ABs. They still believed that they were practising ABU in a "considered manner". They did not think they used ABU abusively. Moreover, there were a group of farmers who had tried or intended to seek alternatives to ABs. It could be a favourable sign for engaging farmers in an effort to reduce ABU on farms. However, due to a limitation of the cross-sectional KAP survey, the study did not provide qualitative information to explain their decisions and motivations. Therefore, more data was aimed to collect from the study site in 2017 and 2019 in order to offer an explanation. The results are presented in chapter 7 and 8

where farmers' reasons for the choosing between therapeutic and non-therapeutic ABU, their motivations and values driving their decisions and practices are analyzed.

5.5 Conclusion

In summary, farmers in this study had limited knowledge of ABU and ABR and they conducted inappropriate ABU practices on their farms. They used ABs for non-treatment purposes or adjusted the AB dose. Farmers based their ABU decisions on their own experiences rather than complying with recommendations from drug manufacturers or seeking advice from veterinarians. The majority of farmers acknowledged the necessity of ABU but they did not think they overused ABs. About one-third of the studied farmers had tried to apply alternatives to ABs because of their perceptions of adverse side effects of ABU to animal health and production costs. The analysis did not find any significant associations between farmers' and farms' characteristics and current farmers' understanding, attitude and practices related to ABs and ABU. A limited knowledge of ABU and ABR was found not to be significantly associated with inappropriate ABU practices. However, participation in the training events, which were mainly held by drug companies, was identified as the risk factor for the inappropriate ABU practices among farmers. The more they participated in these training events, the more they adopted the use of ABs for non-therapeutic purposes.

Chapter 6

FARMERS' PERCEPTION AND PRACTICES RELATED TO ZOONOTIC TRANSMISSION

6.1 Introduction

Antibiotic resistance (ABR) has been identified as a zoonotic health threat (Angulo et al., 2004). Resistant bacteria can transfer between animals and humans at the human-animal interface. In Vietnam, using whole-genome sequence, the zoonotic clonal spread of colistin-resistant bacteria between chicken farmers and chicken was identified (Trung et al., 2017).

The presence and transmission of zoonotic pathogens on livestock and poultry farms depends on several factors including the species of animals being raised, level of veterinary care, management style, farm location and agricultural practices (LeJeune & Kersting, 2010). With poor hygiene and prevention practices, farmers and their families could ingest pathogens harboured in faeces, urine or reproductive secretions of animals (Collins & Wall, 2004). In addition, ineffective treatment, disposal, and handling of infectious material could also result in the contamination of animal pens, soil, gardens, surface and underground water supplies and animal feed (Weber & Rutala, 1999), which make animal farms becoming microbiological reservoirs. To reduce the risk of zoonotic infections for farmers, it recommended that appropriate use of personal protective equipment (PPE) and personal hygiene practices should be adopted (Weber & Rutala, 1999). PPE includes eye protection, masks, coveralls or aprons, gloves, and shoes. Personal hygiene includes frequent hand washing, bathing, and precautions

against transporting zoonotic agents on clothing, hands, or footwear into the home or community (LeJeune & Kersting, 2010).

Farming livestock and poultry is considered a high-risk occupation for zoonotic transmission of resistant bacteria (Klous et al., 2016; Neyra et al., 2012). The transmission of zoonotic pathogens is a consequence of daily exposure to microorganisms associated with animals. Social habits which could expose farmers to zoonotic risks such as backyard farming or home slaughter should be highlighted, especially in low-middle income countries like Vietnam where there is a dominance of household farms (Battelli, 2008; Horby *et al.*, 2013). Furthermore, animals carrying potentially harmful pathogens may still appear healthy or asymptomatic. Therefore, farmers and their family members could be unaware of the possibility of exposure to and contracting transmissible and potentially dangerous zoonotic agents (Battelli, 2008). Moreover, those living and working on farms might not share the same level of risk due to differences in additional risk factors such as age, gender or immunity status (LeJeune & Kersting, 2010).

Results shown in chapter Five indicate that the studied farmers had limited understanding of ABR. Very few of them were aware that ABR is a process of bacterial adaptation or bacterial modification to survive exposure to ABs. The majority of them defined ABR as causes of slow growth or poor productivity of animal production, implying an inappropriate understanding that the animal body became resistant to antibiotics (ABs) (WHO, 2018). In this study, I consider whether farmers were aware of ABR zoonotic bacterial infections as a potential health risk via occupations exposure, and did they adopt any plans or solutions for managing this risk.

This chapter aims to explore farmers' perceptions of risk and preventative solutions for zoonotic infections, including ABR zoonotic bacteria, and their farming practices. To the best of my knowledge, this is the first study on this topic in the Mekong Delta region in Vietnam where farmers' livelihoods are tightly linked with livestock and other agricultural activities. It sheds light for us to understand farmers' views on the potential impacts of animal husbandry on their own health. It explores what issues farmers are most concerned about when making decisions about farming practices.

6.2 Methodology

Data for analysis in this chapter was extracted from the knowledge, attitude and practice (KAP) survey with a structured questionnaire (Appendix A-2). Three groups of questions were asked to measure farmers' knowledge, attitude and practices. To avoid potential bias and leading the answers if questions of knowledge and attitude come first, the questionnaire started with given questions in a "yes-no" format about facts of farming practices related to animal health care, farm management, farm hygiene and human health protection solutions. Besides that, information about farming practices was also collected from observations. I conducted observations in each farm to take note farmers' daily farming practices, hygiene conditions such as the application of biogas or other waste treatment, and the common practices to deal with animal disease and dead.

To test how much these farmers were aware of zoonotic diseases (ZD), a list of seven diseases was then given. Of the seven diseases, four were defined in *"Guidelines for coordinated prevention and control of zoonotic diseases"* issued by MARD and MOH

in 2013. These are H5N1, *Streptococcus suis (S. suis),* Leptospirosis and Taeniasis. Taeniasis was included since it originated in pigs and was a common parasitic zoonotic disease in Vietnam (Van De *et al.*, 2014). Three non-ZDs in the given list were Newcastle, Porcine Reproductive Respiratory Syndrome (PRRS) and Foot and Mouth disease (FMD), which were major diseases occurring in either chicken or pig farms in Tien Giang, according the reports by SDAH Tien Giang in 2016. The third question was about the effects of AB overuse on human health. This was an open-ended question to explore whether farmers were aware of ABR as a potential zoonosis and all 100 farmers were asked this question. The last question was about solutions they believed could prevent the transmission of infections between animals and humans.

To measure aspects of attitude, all farmers were asked five questions to determine their definitions of safe farming, judgment of their level of safe farming, risks of contracting diseases, and reasons for their answers. The aims of these questions were to interpret how farmers evaluate their health risk when they have close contact with animals.

For analysis, both univariate and multivariate analyses were used to investigate potential risk factors associated with farmers' knowledge of ZD, their judgement of zoonotic risk and safe practices, and farming practices. Potential risk factors could be from farms' or farmers' characteristics such as type of animal, farming scale, and farmers' age, gender, education level, farming experience, and participation in local training events. The mean-value of ZD knowledge was based on the number of correct answers farmers provided when they distinguished ZD and non-ZD from a given list of seven diseases. The mean-value of eleven preventative practices was based on the number of answers confirming they had done the practice frequently. Variables were

considered as a candidate for multivariate analysis based on their plausibility and a P-value <0.05 in the univariate analyses. In the final multivariate models, variables were retained if their P-value was <0.05. All interactions between all significant variables in the model were assessed.

6.3 Results

6.3.1 Farmers' knowledge of zoonotic risk and prevention

6.3.1.1 Limited understanding of zoonotic diseases

The majority of participants (80, 80%) were able to provide an answer when asked to list any zoonoses they know. Of those, 58 farmers (72.5%) could list at least one zoonotic disease, such as H5N1 (56 farmers (96.6%) and *S. suis* (27 farmers, 46.6%). The other 22 farmers (27.5%) listed both H5N1 and other typical animal diseases such as PRRS, FMD, or Infectious Bursa Disease ("Gumboro" in chickens) as zoonotic diseases.

Table 6.1 The proportion of correct answers in identifying zoonotic diseases

		Chicken farmers (n=47)	Pig farmers (n=33)	Total (n=80)
Non-zoonoses	PRRS	22 (47%)	16 (48%)	38 (48%)
	Newcastle	25 (53%)	17 (52%)	42 (53%)
	FMD	23 (49%)	16 (48%)	39 (49%)
Zoonoses	S.Suis	16 (34%)	23 (70%)	39 (49%)
	H5N1	46 (98%)	31 (94%)	77 (96%)
	Leptospira	11 (23%)	9 (27%)	20 (25%)
	Taeniasis	29 (62%)	13 (39%)	42 (53%)

Data obtained from asking these 80 farmers to classify ZDs from a list of seven diseases showed that 28 farmers (35%) could provide five to seven correct answers. Almost all farmers (77, 96%) had a correct answer towards H5N1. Except for Leptospira (20, 25%), the proportion of correct answers in the other listed diseases was around 50%. There was no difference between pig and chicken farmers in the proportion of correct answers, except for two cases of *S. suis* and Taeniasis, which were all pig-originated diseases. More pig farmers (23, 70%) knew *S. suis* as ZD than chicken farmers (16, 34%), while in contrast, more chicken farmers (29, 62%) knew Taeniasis as ZD than pig farmers (13, 39%) (Table 6.1).

When asked whether the overuse of ABs in livestock could cause impacts to human health, the majority of farmers said that it possibly influenced human health with mild or severe impacts (Table 6.2).

Table 6.2 Possible effects of antibiotic overuse on human health

	Farmers' health (n=100)	Consumers' health (n=100)
Mild effects	62	34
Severe effects	23	52
No idea/ Difficult to answer	15	14

However, when asked to describe the specific possible impacts, the majority provided no answer or said, *"It could be harmful to human health later but I don't know exactly". A* few farmers shared their doubts of the potential impacts of frequent exposure to ABs on farms or unsafe meat consumption leading to "*being poisoned, tired or even having*

cancer". In addition, no farmers mentioned infections with ABR bacterial pathogens from livestock farms as ZD.

6.3.1.2 For preventing zoonotic infections: focusing more on environmental and hygiene issues

Three groups of solutions, which were farmers' own ideas for the prevention of zoonotic infections from 80 farmers when answering the open-ended question "*what solutions do you think we could do to prevent zoonotic infections?*", were summarised. In summary, five farmers (6%) said that no preventative actions could be taken. More pig farmers (4, 12%) mentioned this idea than chicken farmers (1, 2%). The explanation included nothing could or should be done to prevent zoonotic transmission, either because it was an unavoidable risk to accept when handling animals or because they had no solutions. The remaining farmers (75, 75%) suggested eleven solutions which were classified into two groups of ideas: protecting human health and protecting animal health. Protecting human health included practicing personal hygiene and other safe practices.

Practicing personal hygiene included washing hands and wearing PPE during animal handling (mentioned by 48 farmers, 60%); farms not adjacent to family houses and not slaughtering or consuming sick animals or raw meat (mentioned by 8 farmers, 10%). Solutions for protecting animal health aimed to improve farm hygiene management (34 farmers, 43%) and prevent animal diseases "*to keep animals healthy*" (9 farmers, 11%) (Table 6.3).

Table 6.3 Famers' solutions for prevention of zoonotic transmission

Solutions	Total (n=80)	Chicken farmers (n=47)	Pig farmers (n=33)
Environmental and hygiene issues	66 (83%)	39 (83%)	27 (82%)
Protecting human health	48 (60%)	29 (62%)	19 (58%)
1 Wearing a mask	31 (39%)	21 (45%)	10 (30%)
2 Washing hands and bodies	20 (25%)	13 (28%)	7 (21%)
3 Wearing protective clothes	18 (23%)	7 (15%)	11 (33%)
Protecting environment	34 (43%)	19 (40%)	15 (45%)
4 Good farm hygiene practices	31 (39%)	17 (36%)	14 (42%)
5 Frequent disinfection	1 (1%)	1 (2%)	0 (0%)
6 Burning/burying detected animals	3 (4%)	2 (4%)	1 (3%)
In connecting with animal diseases	24 (30%)	12 (26%)	12 (36%)
Protecting human health	8 (10%)	4 (9%)	4 12%)
7 No slaughtering/eating sick animals	*6 (8%)*	*4 (9%)*	*2 (6%)*
8 Locating farms far from houses	2 (3%)	1 (2%)	*1 (3%)*
Protecting animal health	9 (11%)	4 (9%)	5 (15%)
9 Vaccination	*8 (10%)*	*4 (9%)*	*4 (12%)*
10Isolating sick animals	*5 (6%)*	1 (2%)	*4 (12%)*
*11 Adopting all-in-all-out**	*3 (4%)*	3 (6%)	0 (0%)
Doing nothing	5 (6%)	1 (2%)	4 (12%)
Can't do anything to prevent zoonosis transmission	*2 (3%)*	*0 (0%)*	*2 (6%)*
Do not know what to do	*3 (4%)*	1 (2%)	*2 (6%)*

* "A*ll-in-all-out*" farm management implies the removal all of animals from an animal house; then cleaning, disinfecting or drying the house before introducing a new batch of animals into that house.

Overall, farmers saw the risk of zoonotic infection as labour safety and hygiene issues, therefore their ideas more focused on solutions for dealing with these issues to protect both human and animal health (66, 83%). While in contrast, they seemed to be less aware of the link between animal diseases and ZD, thus, not many of them mentioned solutions to prevent exposure to animal pathogens (24, 30%).

6.3.2 Farming practices: a difference between those reported and observed

6.3.2.1 Implementing more solutions for prevention of animal diseases than to protect farmer's health

Based on the groups of eleven practices that farmers considered as solutions for zoonotic prevention (Table 6.3), we investigated how farmers implemented these practices in reality. As shown in the previous section, farmers highlighted the role of labour safety and hygiene issues for zoonotic prevention. However, in daily farming practices, farmers focused more on animal disease prevention via vaccination and disinfection, but less on human health protection (Figure 6.1).

For animal disease prevention, all farmers (100%) reported that they vaccinated their animals and earnestly followed the schedules and instructions of both local vets and experts from drug companies. Farmers acknowledged the role of vaccination for animal disease prevention and that this practice had been in place for ten years after farmers experienced the effective protection of vaccination for their animals. They could compare profit and loss between vaccination and non-vaccination. They also showed us the vaccination schedules on their farms and the costs involved to highlight that

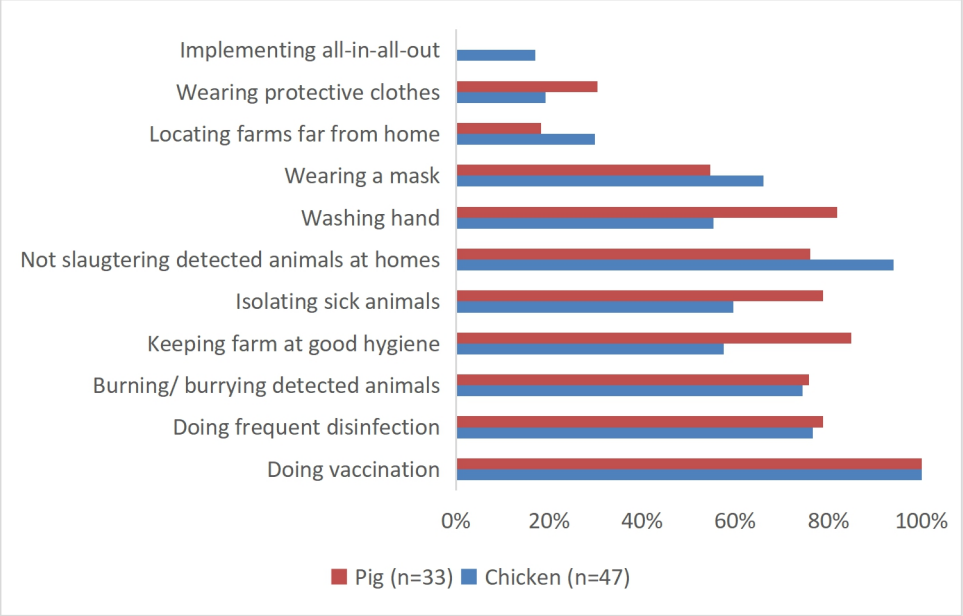
vaccination was not a voluntary practice as before but was now one of the mandatory production costs. Similarly, nearly 80% of the farmers said that they frequently conducted disinfection on their farms. However, we also noted that the frequency could be one to two times per week for pig farms or one to two times per month for chicken farms, depending on farmers' experience. Farmers could also increase the frequency of disinfection if they heard about any disease outbreaks in their surroundings. There was also a high proportion of farmers reporting the frequent practice of burning or burying detected animals and keeping farms at a good hygiene level (75%).

When it came to protecting their own health, farmers tended to ignore the practices which could prevent them being frequently or directly exposed to animal pathogens. Data showed that about 70% of farmers did not wear gloves or protective clothing while working on animal farms. Furthermore, the animal farms were in very close proximity to human houses. Among 62 study farms which provided the estimated house to farm distance, 42 farms (67.7%) were next to the family house with less than ten meters. The remaining 20 farms (32.3%) reported a more than ten meter distance between the farm and the house. However, these farms still used pens or animal houses next to the house for keeping pregnant sows or broiling chicks. These were for convenience for looking after sows or chicks.

Overall, farmers took care of their animals as best they could to prevent disease. However, they were not likely to practice full measures to protect their own health. In addition, we observed the existence of unsafe farming practices among these farms via observing how farmers dealt with animal waste and death, from farm observations and

interviews showing their limitation in recognizing zoonotic risk on livestock and poultry farms.

Figure 6.1 The implementation of safe farming practices that farmers considered as solutions for zoonotic prevention, divided by farm type



6.3.2.2 The limitation in recognizing zoonotic risks from unsafe farming practices

Several unsafe farming practices were observed including those in managing farm-waste, and handling sick or dead animals. There is a requirement for farms to have a waste treatment plan and is applicable to all farms from household level. Chicken farm owners are recommended to use soft bedding, such as straw or (rice) hulls, on the floor to collect chicken droppings, which is then frequently sprayed with an effective anti-microorganism product (EM) for several days or weeks until collection. This approach was expected to get rid of bad smells, a sign of successful waste treatment, from

chicken droppings on farms if implemented correctly. Among 53 chicken farms that implemented this approach (100%), we detected no bad smell from chicken droppings in only two farms (3.8%) which had accumulated chicken waste on the floor bedding for collection at the end of production cycle but uniquely had cement floors. The other farms, which also kept the chicken droppings to be collected at the end of production cycle, had soil floors. The farmers of the latter farms knew that their farm waste treatment plan was failing due to being undertreated. This was due to the accumulation of a thick layer of bedding and chicken droppings reaching the bottom of the chicken cages. This then prevented farmers from effective spraying of EM product on the chicken waste due to the lack of space. They avoided spraying EM product on their chickens down to the waste below. They also decided not to collect chicken droppings more frequently to save on farming costs and due to their experience of triggering respiratory symptoms post-waste collection.

The recommended, available and most affordable farm waste treatment plant for pig farms is a biogas system with different designs from cement to hard or soft plastic tank. We detected the smell of pig faeces in all 47 pig farms (100%), including the 31 (67%) farms that had a biogas plant installed for waste treatment. From discussions during farm visits, we learnt that pig farmers were aware and explained the smell was the result of the biogas plants not having enough capacity. This was because the biogas plants were installed when the farms were much smaller with fewer pigs. Some farmers did not have sufficient spare plots of land to install appropriate ones, whose capacity for waste treatment should be compatible with the number of animals reared on farms.

Others did not see the necessity and did not have the motivation to upgrade the current system even though they were aware of the consequences of environmental pollution. Furthermore, farmers did not have sufficient waste treatment methods, increasing their risk of contracting zoonotic pathogens from a contaminated environment. Pig farms discharged animal and water waste freely and directly into the drains or settling ponds. Mud from such ponds was then used as fertilizer for coconut trees and other fruit trees planted within the farm land.

Figure 6.2 A thick layer of bedding and droppings reaching the bottom of cages (→ : Bedding and droppings)

Chicken farmers usually collected manure and bedding periodically after 7 to 10 days for fertilizer purposes. No other ways were seen to treat waste from chicken farms, except bagging it and calling collectors. These collectors would then sell these bags to crop farms, mainly located in the community.

Although more than 80% of farmers reported that they did not frequently slaughter and consume sick animals, it was found that they had various strategies including unsafe practices when dealing with sick or dead animals. Table 6.4 shows the strategy farmers

followed depended on the stage of animal development and its health status. Reasons for their decisions were also collected.

It could be seen that their decisions were driven not only by economic motivation but also by their awareness towards animal disease prevention. For farmers, the decision could be seen as a quick response to mitigate both economic loss and disease transmission among animals.

Table 6.4 Common practices to deal with animal disease and death

Animals & Status	Practices	Farmers' reasons
Chicks, death by any reason, including infectious diseases.	Feeding fish or pythons without cooking; Feeding to dogs after cooking	Saving cost for feeding fish, pythons or dogs
Chickens at adult age, still alive, during the outbreak of diseases on farms, including infectious diseases	Calling to traders and selling the whole flock before the disease causes any serious loss While waiting for traders, dead chickens would be buried	Preventing serious economic loss and trying to keep capital investment To prevent transmissions to the whole flock
Piglets, (one or two weeks old) death by any reason, including infectious diseases	Burying	To prevent disease transmission which could affect other piglets
Small pigs (15 - 30 kg), death or going to die for any reason, including infectious diseases	Calling to traders and selling for a cheap price These pigs will be roasted and sold in the local markets.	Preventing serious economic loss, trying to keep capital investment
Adult pigs, death or going to die due to abortion, or other reasons which farmers thought were from non-infectious diseases	Slaughtering and consuming animals at home if sick animals were not in a course of AB treatment	Farmers said that such meat was safe to eat.
Adult pigs, not responding to the course of treatment of any disease, including infectious diseases	Calling traders and selling with a cheap price. Since traders prefer buying live pigs rather than dead ones, farmers would decide to sell their animals when the animals were still alive, even when animals were using ABs.	Preventing serious economic loss, trying to keep capital investment

It was noted that farmers were aware of the potential harm of animal diseases to their health if they slaughtered or consumed sick or dead animals which had infectious diseases or an incomplete course of ABs. Farmers defined pork or chicken meat from sick or dead animals as “unsafe meat”. They also worried that they could purchase unsafe meat in the local markets. However, they did not take into account the potential harm to other consumers when they decided to sell sick or dead animals to compensate for economic loss. They said “*I have no choice. I have to sell them (sick or dead animals) as quickly as possible before I can’t anymore. If not, I will lose income.” (H23, a farmer from a small pig farm.)*

6.3.3 Farmers’ judgment: Underestimation of zoonotic risk

The previous sections showed that farmers primarily identified H5N1 as a ZD and focused on labour safety and hygiene issues as solutions for prevention. However, their practices on farms were mainly to protect their animals’ health. This section will explore how farmers judge the safety of their farming practices and their risk of contracting diseases from farm animals.

Except for a few who had no idea about the risk (10, 10%), one-third (26, 26%) perceived themselves at high risk, while the remainder (64, 64%) perceived themselves at low and no risk of zoonotic infections. Among the 64 farmers who judged themselves at low to no risk of zoonotic infections, the majority said that they were conducting safe farming practices (45, 70.3%). While in contrast, 15 (57.7%) of those who judged themselves to be at high risk (26, 26%) said they were still conducting

unsafe farming practices. Data also showed a significant association between risk judgment and current belief about safe farming practices (OR 0.3, 95% CI 0.1-0.7, P-value=0.01) (Appendix Chapter 6 - Table 1).

However, this judgment was likely to be subjective, since there was not a statistically significant difference in the mean value of 11 safe farming practices between the two groups of farmers, who judged themselves to be conducting either safe or unsafe farming practices (respective mean value of 7.9 and 7.6, p-value= 0.4). Therefore, to interpret the link between the two judgments, data from an open-ended question was analyzed.

Explanations for the perception of low- or no- risk of ZD

Those saying they had low- or no- risk of contracting diseases from animals, their reasons were based on past experiences of not getting infected and a belief that they had already conducted safe farming practices, including preventing animal diseases via vaccination. A common statement shared among 'no health risk' perceiving farmers was:

> "*I take care of my animals every day, even during the outbreaks of diseases with bare hands and no mask. But nothing happened to me.*" (A farmer from a small sized pig farm)

The statement "*nothing happened to me*" was also repeated by those who perceived themselves at low risk. To these farmers, contracting zoonotic diseases might happen due to their daily contact with animals, however from their experience *"the risk is very small and insignificant"*.

"I have not experienced any zoonoses…. If the transmission is via the air, actually, we cannot recognize and prevent it. However, I have not seen anyone getting serious infections so far. I think the risk is very insignificant …" (A farmer from a medium sized pig farm)

Furthermore, some of them also excluded themselves from health risks because they thought they were not exposed to animals very much. They thought that young animals were safe and not a source of zoonotic infections.

"*I am not exposed too much to chickens, because the farming cycle for each flock of black chickens is very short, just four weeks. I sell them at four weeks old, there is not too much risk of disease or too much waste from them*." (A farmer from a small sized chicken farm)

Several farmers thought that because they did active disease prevention for their animals by vaccination they had low risk of zoonoses.

"*The key is that you should protect your animals from diseases. If they are healthy and have no diseases, why do you need to worry about disease transmission to human? For example, bird flu, we don't worry much, because all flocks are vaccinated from a few days old" (A* farmer from a medium sized chicken farm.)

Explanations for the perception of high risk of ZD

Among those seeing themselves at a high risk for zoonotic infection (26, 26%), their reason was that they are more frequently exposed to polluted animal waste and infected animals than other non-farming people.

"*People usually say "to live with the sword and die by the sword". We have very close contact with animals, with pathogens circulating on farms, so we can be infected with such pathogens if our health is poor. But we cannot stop raising livestock because it is our job and income. We have to accept this risk.*" (A farmer from a medium sized pig farm)

The outbreaks of H5N1 built their awareness of the possibility of zoonotic transmission between animals and humans, including other zoonoses which they had not known yet, and livestock farms were a potential source of infection to humans. Therefore, they accepted zoonotic infections as one of their occupational risks.

"We are so worried about the infections from animals, but we cannot quit our job. We visit the clinic every six months to test to find out if we have any infections. I also often remind my husband and sons to do frequent disinfection not only for the farm but also for themselves when pigs get sick." (A farmer from a medium sized pig farm)

However, although farmers judged themselves at high risk of ZD, they could not explain why they were still safe during H5N1 outbreaks in their community between 2004 and 2006. Their suspicion existed without conclusive explanations.

"We know some farms had about 5000 - 7000 poultry die because of H5N1, but the owners were safe. We don't know why, but we think the disease is not easily transmitted to humans." (Focus group discussion in a chicken commune.)

To deal with anxiety and suspicion, these farmers sought solutions for reducing their zoonotic risk. A range of practices was described paying attention to both environmental and hygiene issues such as frequently performing cleaning and

disinfection on farms and following protective practices such as wearing a mask when handling animals. However, about a half of respondents in this group thought that zoonotic infections could not be completely prevented by these solutions. That is the reason they judged themselves at high risk.

> "*I just try to be more careful when working on the farm, such as wearing a mask when I shower the pigs. I don't know how to do more, what will be will be."* (A farmer from a medium sized pig farm)

6.3.4 Risk factors influencing knowledge, practices and judgment about zoonoses

Data from both uni- and multivariate analysis showed that females and those who had education at the primary level had less understanding of zoonoses. Other demographic and farm characteristic variables such as age, years of experience, training event participation, and farm type or scale, did not show any statistically significant association with farmers' knowledge, attitude towards zoonotic risk and level of safe farming practices (Appendix B- Chapter 6 – Table 1).

When exploring farming practices, there was a statistically significant difference in mean value between the two farm types (p-value=0.002). Chicken and small farms had a lower mean value than pig and medium sized farms. This shows that pig and medium sized farms implemented safe farming practices more often than chicken and small farms since they believed this to be a solution for zoonotic prevention. Meanwhile, demographic characteristics as gender, education, age, years of experience, and training

event participation, did not show any significant difference in conducting farming practices.

Table 6.5: Results from univariate analysis

	Understanding of ZD (7 diseases)			Self-judgment of zoonotic risk				Self-judgment of safe farming practices							Safe farming practices (11 practices)		
				No. part (n= 95)	Uni-variable analysis			No. part (n= 100)	Uni-variable analysis			Multi-variable analysis			Independent T-test		
	Mean	95 % CI	P-value		OR	95 % CI	p value		OR	95 % CI	P-value				Mean	95% CI	P-value
Gender		0.5 - 2.2	**0.01**													(0.1)- 1.0	0.1
Female	2.20			23/30	1.5	0.5-4.2	0.5	9/35	0.4	0.1-0.9	**0.05**	0.3	0.1-1.0	0.06	9.1		
Male	3.58			41/60	Ref			30/65	Ref						9.6		
Age (median, (IQR)		(0.9)- 0.7	0.8													(0.4)- 0.7	0.6
<=40	3.07			18/26	0.8	0.3-2.4	0.8	10/39	0.7	0.3-1.8	0.6				9.4		
>40	3.17			46/64	Ref			29/71	Ref						9.5		
Education		0.6 - 2.4	**0.03**													(0.6)- 0.6	0.9
Secondary & above	3.44			48/69	Ref			34/77	0.3	0.1-1.0	0.08				9.4		
Primary	1.96			16/21	1.4	0.5-4.3	0.8	5/23	Ref						9.4		
Years of experience (median, (IQR))		(0.02) - 1.4	0.8													(0.7)- 0.5	0.6
3-6 years	3.23			20/26	1.5	0.5-4.3	0.6	15/31	1.7	0.7-4.1	0.3				9.5		
>=7 years	3.94			44/64	Ref			24/69	Ref						9.4		
Training event participation		(-0.1)- (1.4)	0.1													(0.3)- 0.7	0.4
n>2	3.43			29/45	Ref			18/49							9.5		
n<=2	2.78			35/45	1.9	0.7-4.8	0.2	21/51	1.2	0.5-2.	0.7				9.3		

									6							
Farming scale		(0.9)-0.7	0.8												(0.6)-0.4	0.7
Small size	3.13			43/48	1.5	0.5-3.8	0.5	25/63	1	0.40-2.4	1			9.5		
Medium size	3.05			21/32	Ref			14/37						9.4		
Type of animals		(0.3)-1.3	0.21												0.08-1.1	**0.02**
Chicken	3.34			33/48	0.8	0.3-1.9	0.6	19/53	0.7	0.3-1.6	0.5			9.7		
Pig	2.83			31/42	Ref			20/47						9.1		
Risk judgment		(0.3)-1.4	0.2												(0.8)-0.4	0.5
Low to no risk	3.1							19/64	0.3	0.1-0.7	**0.01**	0.3	0.1-0.8	**0.02**	9.5	
High risk	3.7							15/26							9.3	
Safe farming judgment		(1.0)-0.3	0.3												(0.9)-0.4	0.4
Unsafe	3.6														9.5	
Safe	3.9														9.3	

6.4 Discussion

Overall, farmers had limited knowledge of zoonoses. Although ZD was not a new concept to at least 80% of the study farmers, only H5N1 was correctly mentioned as ZD by just more than half of them (56, 56%). This could be because Tien Giang was one of the first provinces to report outbreaks of H5N1 and suffered severe economic loss in poultry production in early 2004. Between 2004 and 2005, a loss of about 1.8 million poultry was estimated due to infection or culling (Department of Agricultural and Rural Development in Tien Giang province in 2005).

The misidentification of ZD as only animal diseases could happen when some diseases are more common in many types of animals and cause mild sickness in humans. For example, leptospirosis could be found in the wild environment, water and domestic animals like dogs, rats and pig (Victoriano *et al.*, 2009). Almost 50% of pig farmers did not correctly identify PRRS and FMD as animal diseases, which occurred quite frequently in the last decade in Vietnam and Tien Giang (T. Nguyen *et al.*, 2013; Zhang & Kono, 2012). This should be corrected since *S. suis* was found to co-infect with PRRS in sick pigs originating from this province. Moreover, human *S. suis* infections have shown to be associated with PRRS outbreaks in Vietnam (Hoa *et al.*, 2013).

Our findings clearly show that farmers had no knowledge of the potential impact of ABU and ABR from pig and chicken farming on the emergence of ABR pathogens. It could be that resistant microbes are invisible to farmers so they could not link zoonotic transmission of resistant microbes to their own health risk because often ZD are asymptomatic, or can be mistaken for other human diseases such as skin infections, diarrhoea or respiratory illnesses (Battelli, 2008).

Generally, farmers underestimated the possibility of contracting zoonotic pathogens from animals and did not see zoonoses as a potential occupational risk. It was because they witnessed or experienced a low incidence of zoonotic infections. As laypeople, farmers only took into account zoonoses of fatal illnesses and those causing epidemics or pandemics such as H5N1. In addition, when farmers referred to their experience of not becoming infected during H5N1 outbreaks, they showed their misunderstanding of zoonotic risk. They were not aware that they could share the different levels of transmissions due to differences in age, gender, or immunity status (LeJeune &

Kersting, 2010). The occurrence of undiagnosed zoonotic infections and the complex additional risk of acquiring zoonotic infections could lead to underestimating the possibility of contracting pathogenic agents from animals (Maudlin et al., 2009).

With regards to solutions for preventing zoonotic transmissions, the literature shows a requirement for a combination of animal disease control and solutions for preventing transmissions via PPE and personal hygiene practices (Weber & Rutala, 1999). In this study, the majority of farmers were aware of poor hygiene conditions and close contact with animals as factors affecting an increase in the possibility of zoonotic transmissions from animals to humans (78%). Therefore, their solutions mainly targeted hygiene issues and protective practices for preventing infections such as wearing a mask or gloves or their washing hands. However, a few of them (30%) recognized the connection between animal disease control and zoonosis prevention. In daily farming practices, the farmers showed their priority was to control animal diseases to protect animal health to ensure productivity and income rather than human health protection. It could be, unlike zoonoses, farmers had a lot of experience with high incidence of animal disease and economic loss from animal loss if infections occurred. This analysis shows an existing gap between perceptions and practices. Farmers showed they were well aware of solutions to prevent zoonotic infections, however, they were not motivated to comply because preventing zoonotic infections was not their primary concern.

With regard to farming practices, farmers still conduct some unsafe behaviours or habits such as locating farms close to houses, inappropriate waste treatment systems, and unsafe solutions for dealing with sick and dead animals. The poor status of farming

facilities, traditional farm management and habits, as well as a lack of services supporting livestock husbandry, could be barriers to promoting safe farming practices and adapting to a quick shift from subsistence to commercial farming (Thornton, 2010). Furthermore, up to two-thirds of farmers thought that they already conduct safe farming practices. This finding suggests that farmers did not recognize their practices as unsafe, which could cause the spread of pathogens circulating in the environment and animal diseases, including potential zoonotic infections. They also used ABs as a "quick fix" for dealing with animal sickness and infections (L. D. Willis & Chandler, 2019). Meanwhile, no one was aware that resistant bacteria is a kind of potential zoonotic infections.

Results from uni- and multivariate analyses indicate that to improve farmers' knowledge of zoonoses, female farmers and those with low education should be targeted because they had less understanding of this topic than their counterparts. These two factors could be also concluded as preventing farmers from approaching and comprehending information to increase their awareness (T. R. Kelly *et al.*, 2018; Tebug *et al.*, 2015). In Vietnam, livestock farming is a traditional occupation, a favourite choice of the poor and people with low literacy who have less chance for other work in the labour market, and of women, who would like to fulfill their role as housewives in taking care their family and earning additional income for household livelihood (Chi *et al.*, 2015; Quang, 2018; Rapsomanikis & Maltsoglou, 2005). Therefore, these groups of farmers should be provided information and skills to increase their awareness of ZDs and prevention solutions. Although gender difference was not the target of this study, from interviews and observations it was found that women were more engaged in the

activities of cleaning or sanitizing the farms and consequently were exposed to animal waste and potential pathogens. Meanwhile, their attendance at seminars, workshops or training programs was lower than their husbands who attended meetings on behalf of their households (Chi *et al.*, 2015). Therefore, the gender dimension should be focused on more in future studies to establish appropriate and feasible strategies for including females in intervention programs.

Overall, there was a visible gap between the subjective judgment of farmers and scientific evidence about zoonotic risk. To fill this gap, multiple approaches are required from different stakeholders. In line with other studies, data from this study suggests that when farmers do not have sufficient information about zoonotic diseases, it is difficult for them to make appropriate judgments of the risks and apply appropriate practices (Bostrom, 1997). Lack of data on zoonoses and inadequate communication between veterinary and human health care professionals could cause limited knowledge of zoonoses among farmers (Swai *et al.*, 2010). Therefore, providing sufficient and proper information as guidelines to improve farmers' knowledge of zoonoses and safe farming practices should be the first step to raise awareness and motivation for farmers to be more proactive in adopting strategies to prevent zoonotic infections. Similar suggestions have emerged from studies in other low and middle-income countries (Nahar *et al.*, 2012; OBI, 2016). Furthermore, to promote safe farming practices to protect human health and prevent zoonotic risk for farmers, intervention programs should consider animal diseases as farmers' primary concern. Subsequently, a link between animal diseases and zoonoses should be highlighted, and that controlling animal diseases could be one of the solutions for zoonotic prevention. In addition,

intervention programs should take into account the differences in gender, farm size and type of animals to provide equity conditions and approachability for all farmers.

6.5 Conclusion

The analysis reported in this chapter has shown that the study farmers had limited understanding of zoonotic diseases and underestimated the possibility of contracting diseases from animals. Many farmers did not recognize that they commonly undertook risky practices which could exacerbate animal disease infections and zoonotic transmissions. Their farming practices mainly focused on dealing with animal diseases rather than protecting their own health. They did not recognize zoonoses, including zoonotic infections of resistant bacterial pathogens, as their occupational risk. Therefore, in engaging farmers in efforts to reduce ABU against ABR, intervention strategies should not focus on human health issues since farmers prioritized animal health care and productivity. The focus should be on alternatives to ABs to reduce the threat of ABR on animal health.

Chapter 7

FARMERS' RESPONSES TO THE WITHDRAWAL OF ANTIBIOTIC GROWTH PROMOTERS

7.1 Introduction

The role of antibiotics (ABs) in controlling bacterial infections in farm animals has been documented since the 1970s (Prescott, 2017). ABs have been used in livestock farming as therapeutics for disease treatment, as prophylactics and metaphylactics for disease prevention, and as sub-therapeutics for growth promotion purposes. For growth promotion, ABs are usually mixed in feed with half of the treatment dose to improve daily weight gain and feed efficiency through alterations in digestion and disease suppression (McEwen & Fedorka-Cray, 2002). Animals supplemented with ABs in their feed required 10 to 15 percent less feed to achieve a desired level of growth, resulting in a significant reduction of production cost (Chattopadhyay, 2014; Jukes, 1973).

Epidemiological evidence of an association between antibiotic usage (ABU) in animals and antibiotic resistance (ABR) in humans has been observed for several decades since the 1960s (Timothy F. Landers *et al.*, 2012). In 1969, the Swann Report rang a warning bell that administering ABs to livestock for growth promotion could pose hazards to human and animal health and recommended that alternatives to ABs be investigated (Swann, 1969). Since 2002, the WHO made a call to reduce ABU in livestock production to preserve AB sources for combatting infectious diseases (WHO/CDS, 2000). Since 2006, the European Union (EU) has promulgated the ban of ABU for

growth promotion, following the efforts of Denmark and Sweden since the 1980s. A systematic survey in Denmark between 1992 and 2008 indicated that banning ABU for growth promotion did not negatively impact the long-term productivity of Danish swine farms (Aarestrup *et al.*, 2010).

Vietnam has been identified as a potential hotspot of development of ABR due to high levels of ABU in livestock production (K. V. Nguyen *et al.*, 2013). The Vietnamese Department of Animal Health reported that 70 percent of medicines used in livestock production were ABs (An, 2009). The level of ABU in chicken farms in the Mekong Delta region was six times higher than that reported in the EU and 84% was for non-therapeutic purposes (Carrique-Mas *et al.*, 2015). In 2013 the Ministry of Health (MOH) issued a National Action Plan to combat ABR (Decision 2174/QD-BYT, 2013) and suggested the Ministry of Agriculture and Rural Development (MARD) as the main implementing partner. In 2016 MARD issued Circular 06/2016/TT-BNNPTNT regulating manufacturers' feed content and listing ABs permissible for use as growth promoting substances in livestock feed and the National Action Plan on antimicrobial management commenced in 2017 (Decision 2625/QD-BNN-TY, 2017). In this action plan, MARD repeated the target of gradually removing and proceeding to prohibit the use of ABs mixed in commercial feed for growth promotion from 2018 and for disease prevention from 2020. The first regulation targeted mainly feed producers, forcing the withdrawal of ABs in commercial feed.

In April 2017, the ban of ABs as growth promoters (AGPs) in commercial feed had not been issued yet. However, farmers were aware of the possibility of this ban thank to announcements from feed producers that since 2018, commercial feed would have no

ABs. It was considered whether farmers paid attention to the presence of ABs in commercial feed and if the withdrawal of AGPs from feed make any influence on farmers' practices. This aimed to interpret their responses to the ban and to identify the potential barriers to efforts of stopping ABU for growth promotion through exploring farmers' views towards the presence of ABs in commercial feed and their sub-therapeutic ABU on farms.

7.2 Methodology

For data collection, a question guideline with two sections was designed (Appendix A-3). The questions were mainly open-ended to allow farmers to provide their reasons. From the 100 farmers recruited in the the survey of knowledge, attitude and practices (KAP survey) (Figure 4.1), 81 farmers continued to participate in the study while the others had stopped farming due to personal reasons.

Descriptive statistics were used to find out whether these 81 farmers paid attention to the presence of ABs in commercial feed. The hypothesis was that the level of attention could be seen by examining their criteria for choosing feed, whether they knew the feed they were using contained antibiotic growth promoters or not, which ABs, and their judgment of ABU. Content analysis was used to interpret the reasons behind farmers' judgment of the level of their attention to the presence of ABs and their practice of adding ABs into feed. In the last section of this analysis, the study investigated how farmers implemented their intention of reducing ABU, which was mentioned by a group of 31 farmers in the KAP survey (see Chapter 5, section 5.3.5). Six farmers in

this group did not continue to participate in the additional survey in 2017, therefore this analysis was based on information provided by the remaining 25 farmers.

7.3 Results

7.3.1 Little concern about the presence of ABs in feed

Results from observations showed that all 81 farmers who participated in this study (100%) were using medicated commercial feed, which was supplemented with several ABs for growth promotion purposes. However, data from interviews showed that only 36 farmers (44.4%) were aware of the presence of ABs in the feed they were using, while the others either said “no” (29, 35.8%) or “don’t know” (16, 19.8%). Only fifteen farmers (18.5%) said they had read information related to ABs printed on the feed label. However, only two of the 15 could list the names of ABs matching those printed on the label. Nutritional ingredients (58, 71.6%) and expiration date (30, 37%) were two contents of the feed label that farmers spent time reading.

Farmers chose feed that would result in good animal growth (66, 81.4%) or that had a reasonable price (34, 42%). Sixty-one farmers (75.3%) said they did not often change from their favourite brand of feed. Of 63 farmers (77.8%) who shared reasons why they would consider changing the brand of feed they used, 44 (69.8%) said they would change if their animals showed slower growth and were more susceptible to disease and 25 (39.7%) said if the price of the feed increased. If farmers did decide to change, they would trial the new feed products with a small number of animals first to compare the effectiveness of animal growth before making wide scale changes.

Overall, farmers showed little concern about the presence of ABs in the feed. Their attention was focused on feed efficiency resulting in good animal growth and feed cost. No-one mentioned the consideration of the presence of ABs in the feed as a determinant for choosing or changing feed brands. However, when asked “What is the level of your concern about the presence of ABs in the feed?”, data showed that half of them said “not at all concerned” (40, 49.4%) while the remaining reported "somewhat concerned” (30, 37%) and “extremely concerned” (11, 13.6%). This judgment seemed not in line with what the researcher observed from farmers. The next section will explore farmers’ reasons for their level of concern by using content analysis.

7.3.2 Various subjective views on the presence of ABs in feed

Among 40 farmers saying that they were not concerned about the presence of ABs in feed, two reasons were mentioned. First, they highlighted that their greatest concern was feed efficiency resulting in good animal growth and productivity regardless of whether the feed has ABs or not (29 farmers).

> “*I do not care whether there are ABs (in feed) or not. The most important aspect of feed efficiency is that my animals grow well and do not get sick… If it is no longer effective, I will change it (feed brand).”* (A farmer from a medium sized pig farm.)

Overall, these farmers expected the feed to promote both animal growth and disease prevention. If the feed did not satisfy these expectations, it would be changed.

The remaining eleven farmers in this group felt there was no point in being concerned about the presence of ABs in feed, either because they felt powerlessness to verify the

content of commercial feed or because they bought feed on credit and could not choose their preferred feed. With regard to the former, these farmers pointed out that it should be the responsibility of the government to monitor feed quality and the presence of ABs in the feed; if any feed products were allowed for trade, it meant that they had been already passed the verification.

> *"Why do I myself need to be concerned about ABs in feed? Feed producers have to register with the government who is responsible for verifying it, not us."* (A farmer from a medium sized pig farm)

Farmers who bought feed on credit reported that they did not care about the presence of ABs in the feed because they were unable to choose their preferred feed for their animals. Feed agencies would decide and deliver certain feed brands. Farmers could not make their own choices before they settled their debts, which were often overlapping because they had flocks of different ages with different sale time-points.

> *"I have no choice. It depends on the feed agency. We have to accept the feed which they deliver to us. We are not concerned about anything else."* (A farmer from medium sized chicken farm.)

It was noticed that none of these 40 farmers read the information related to ABs shown on the feed label; and about two thirds of them (25, 62.5%) were not aware of the presence of ABs in the feed they were using.

In contrast, 41 farmers paid attention to the presence of ABs in medicated commercial feed. This was either because they thought ABs were necessary or due to the negative effects of ABs on animal production.

Twenty-two farmers (53.7%) believed that medicated commercial feed was beneficial to animal growth. This was because ABs in the feed could help to "*prevent diarrhea and respiratory diseases"* thereby *"decreasing morbidity and mortality*". ABs also increase good nutrient absorption resulting in rapid weight gain. Some of them (4 farmers) believed that the amount of ABs in medicated commercial feed was not adequate; and therefore, they needed to know which types of ABs were mixed in the feed before adding more of the same. It is noted that three of these four farmers were able to list the names of ABs mixed in their current feed.

The remaining nineteen farmers had opposite ideas to the group above, they focused on three negative aspects of ABs as feed additives to justify their concern. First, they worried about "*ABR in animals*". These farmers believed that the presence of ABs in feed could lead to low drug efficiency in treating infectious diseases in animals.

> *"If my animals have to consume ABs every day, they will become resistant to these ABs. How then can I treat animals if they get infections?*" (A farmer from a small sized chicken farm.)

Secondly, they were concerned that AB residues in animal products could cause harm to consumers' health, however, they could not name any particular illness.

> *"Actually, I prefer the feed without ABs. I don't want antibiotic residues remaining in pork. Consumers will receive all later consequences such as illness. It could occur when pigs are fed medicated feed day by day."* (A farmer from a medium sized pig farm.)

Lastly, farmers considered ABs as medicinal drugs, the misuse of which could harm animal health and growth. They were concerned of the consequences of ABU on

animal health, such as a higher risk of damage to internal organs, stunted growth, and reduced egg or piglet production.

> *"I am concerned that feed producers will mix high volumes of ABs into their feed. It is not good at all. When you first start using such feed, it is effective. But then chickens start showing stunted growth and are more susceptible to infection. With layer hens, I never use medicated feed, no ABs at all, because egg production would decrease." (A farmer from a medium sized chicken farm.)*

Overall, regardless of the level of concern farmers had about the presence of ABs in feed, farmers highlighted these three aspects of their concerns: feed efficiency to prevent animal diseases and promote growth (51, 63%), their worries about potential negative effects of ABs as feed additives (19, 23.5%), and their powerlessness in verifying the quality of feed (11, 13.6%). Only 22 farmers (27%) were aware that the presence of ABs in commercial feed was for growth promotion.

7.3.3 The practices of adding ABs in feed and farmers' reasons

7.3.3.1 The practice of adding ABs into commercial feed

Among 81 farmers, forty-nine farmers (60.5%) reported supplementing AB drugs into feed as sub-therapeutic use. They estimated they used half of the vet-drug producer recommended treatment dose and feed the whole flock of chickens or herd of pigs. It was noted that this practice was regularly carried out by farmers who were also still using commercial feed containing ABs as feed additives. These farmers included those who reported being concerned (23, 28.4%) and not being concerned (26, 32.1%) about the presence of ABs in commercial feed.

There was no association between the practice of adding ABs into feed and levels of concern about the presence of ABs in medicated feed (P-value = 0.4). However, as shown in Table 7.1, it was likely that this practice was more commonly seen in those emphasizing feed efficiency, those feeling powerless, and those who felt ABU was necessary (65.5%, 63.6%, and 68.2%, respectively). Among 51 farmers prioritizing feed efficiency, 34 farmers (69.4%) implemented the practice of adding ABs to feed. However, among 19 farmers concerned about the negative effects of ABs, nearly half of them (8, 42.1%) also reported this practice. Qualitative analysis shown in the next section aims to clarify their reasons.

Table 7.1 Cross tabulation between practices of adding ABs in feed and levels of concern about the presence of ABs in medicated feed

Farmers' level of concerns and reasons		**Adding**		**Total** (81 farmers)
		No (32 farmers)	Yes (49 farmers)	
Not concerned	Optimizing feed efficiency	10 (34.5%)	19 (65.5%)	29 (100%)
	Powerlessness	4 (36.4%)	7 (63.6%)	11 (100%)
Concerned	ABU is necessary	7 (31.8%)	15 (68.2%)	22 (100%)
	Worried about the negative effects of ABU	11 (57.9%)	8 (42.1%)	19 (100%)

7.3.3.2 Reasons for adding ABs into feed

Adding ABs: *"prevention is better than cure"*

All 49 farmers who added ABs in commercial feed for sub-therapeutic use highlighted that this practice was for disease suppression, especially for young animals to prevent the incidence of digestive disorders or infectious diseases. Some of them (22, 44.9%) were aware that the feed they were using for their animals had already been mixed with ABs by feed producers. However, they believed that the volume of ABs already in the feed was not sufficient for disease suppression. They believed that animals were more susceptible, particularly at certain stages of animal growth such as in weaning piglets and one-week old chicks. According to them, this practice was beneficial for active disease prevention, resulting in preventing animal loss, ensuring productivity, and saving on production costs for disease treatment.

> "*If an antibiotic treatment course is one million dong for one day, you should spend at least 5 million dong for a 5-day course (approx. $250). But if you use that AB course for prevention, you spend only 1.5 million dong (approx. $75) for no more than three days. If you wait and only use ABs for treatment, you could suffer huge losses.*" (A farmer from a medium sized chicken farm.)

This illustration shows that farmers decided to implement this practice based on their consideration of economic benefits and concern of animal diseases. They argued that treatment courses were more expensive than sub-therapeutic use. Furthermore, suffering sickness could cause a higher risk of losing animals and farm productivity. They highlighted other economic benefits for them including protecting their animals

from disease, and shortening the raising period, leading to reduced production costs, and increased productivity.

No-one reported that their adding practice was directly for growth promotion purposes. However, they were aware of the connection between preventing animals from suffering diseases and promoting animal growth despite not having further ideas about the mechanism of the effects.

> "*ABs help to prevent diseases. You see, if animals are healthy, they will grow fast. All feed will be absorbed well.*" (A farmer from a medium sized chicken farm.)

With regard to human health, these farmers felt that if animals were healthy, animal products would be safer for consumers. According to them, the issue of AB residue in meat would be solved if they complied with the regulations about a withdrawing period before slaughtering.

> "*Antibiotic residue occurs only when you do not comply with the withdrawal period before slaughtering. If your animals are sick due to not practicing active prevention, you have to sell all before completing the withdrawal period. This practice is harmful to human health."* (A farmer from a medium sized chicken farm.)

The common view was that "*prevention is better than cure*". They recognized the polluted environment, high animal density, and diseases as factors leading to high risk of infection and loss. The farmers argued that these problems could not be easily solved, and in order to reduce the risks they would prefer to use preventative measures. In addition, ABs were readily available to them from pharmacist shops.

"*Animals are raised the traditional way, not in a windowless building or in an automated system, so how can we stop transmission? Vaccines are just for viral diseases. How about diarrhea or respiratory diseases? You know such diseases will happen. Why shouldn't we actively prevent them*?" (A farmer from a small sized chicken farm.)

While also supporting the view "*prevention is better than cure*" and practising adding ABs, a few other farmers raised the point of "ABs are a double-edged sword". They considered both gain and loss in economic and health aspects between adding and non-adding.

"It's used for preventing this disease, but it can cause other diseases. For example, chickens intestines may be damaged by using too much ABs. Antibiotic use also leaves residue in meat and eggs. But I do not advocate maximum restriction of antibiotic use. If you don't use it for prevention, chickens easily contract diseases, leading to low quality eggs and reduced economic efficiency." (A farmer from a small sized chicken farm.)

Not adding ABs into feed: "My animals still grow well without frequent ABU"

Thirty-two farmers (39.5%) reported not adding ABs into feed. They shared the common view that ABs should only be used for treating animal diseases. They defined other uses, including sub-therapeutic use for growth promotion and prevention, as 'misuse', which, to them, leads to negative impacts on both human and animal health and causes economic loss. This loss, to them, was mainly related to an increase in

animal production cost due to purchasing ABs and other supplements to '*detoxify the toxins'* generated from ABU in animals.

> "*You have to spend millions of dong for each round (~$50 for about 5,000 chickens), not only for ABs but also other supplements for detoxifying. It is not cheap at all. How can we afford the cost when the price of eggs is unstable*?" (*A* farmer from a medium sized chicken farm.)

Furthermore, these farmers also experienced a decrease in productivity of eggs and piglets during administration of an AB course: "*Sows could give birth with less (number of piglets) if they are given too much ABs.*" (A farmer from a medium sized pig farm.)

When discussing the negative impacts of sub-therapeutic ABU, farmers mentioned ABR, which could lead to the possibility that ABU for therapeutics would no longer be effective, causing more pain in sick animals.

> "*I had mixed (ABs into feed) several years ago. When my animals got diseases, I couldn't treat them with common ABs due to drug resistance. I had to use two courses to overcome the illness. My animals were terrible at that time. "* (A farmer from a medium sized chicken farm.)

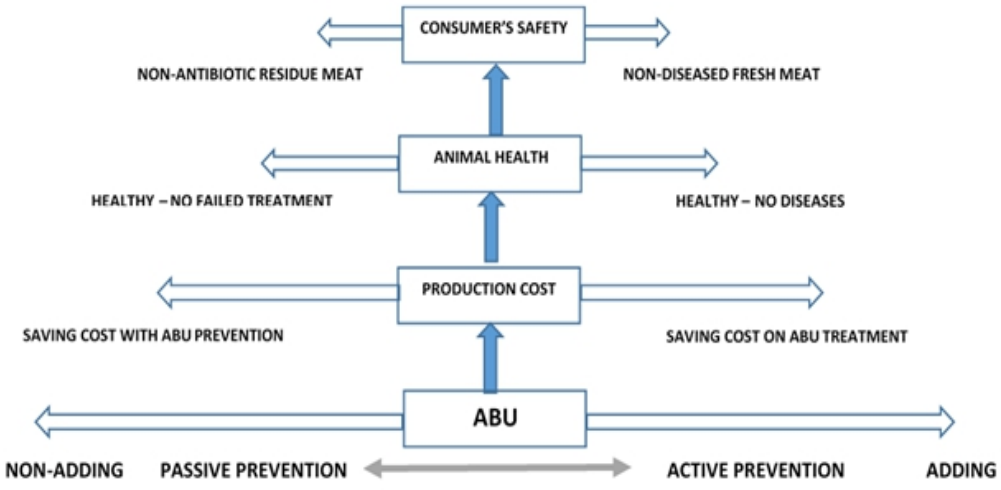
Eight farmers were worried about the negative effects of AB residue in livestock products to consumers' health. Although they were not sure about specific negative effects, they tended to link persistent sub-therapeutic use with residue and the long-term impacts on human health.

"If my animals consume ABs every day, ABs will be absorbed into the meat. Anyone who eats that meat will get sick inevitably. Cancer or skin diseases, maybe, I am not sure." (A farmer from a small sized chicken farm.)

To prevent illness for their animals, these farmers adopted safe farming practices. The common view was that "*my animals still grow well without frequent use of ABs*". They listed alternative methods to ABU which were aimed at increasing farm hygiene conditions and preventing diseases. The methods included isolating the potential sources of transmission and infection, doing periodical vaccination, and providing frequent vitamins or minerals. From their experience, these solutions were efficient in preventing disease and promoting growth.

"*It depends on how careful you are on your farm. You don't need to worry much if you keep your farm clean and do vaccinations regularly. If your animals are healthy, why do you need to use drugs?"* (A farmer from a medium sized chicken farm)

Figure 7.1 Reasons for not-adding and adding ABs into feed



Overall, all the study farmers considered production cost and potential impacts on animal and consumer health in their decisions in livestock farming. However, deciding to add or not to add ABs into feed was based on different perceptions of these three factors. The group adding ABs believed in the benefits of active disease prevention, resulting in producing healthy animals at the stage of slaughtering, which brought benefit to farmers' economic interests, animal welfare and consumer safety. In contrast, the group not adding ABs perceived harms of a routine ABU based prevention approach, which was believed to increase livestock production costs, to cause ABR leading to a loss of drug effectiveness for treating sick animals, and a risk of slaughtering sick or dead animals containing AB residue. The latter group highlighted a necessity of alternative solutions to ABU, including vaccination and keeping farms in good hygienic conditions.

7.3.4 The intention to reduce ABU and practical ABU on farms

Among 81 participants questioned in 2016, 25 (30. 9%) farmers said that they had intentions to reduce ABU on their farm (see chapter 5). Among these 25 farmers, 56% (14 farmers) reported that they used ABs exclusively for therapeutic purposes and had alternatives to ABs for non-treatment purposes. These farmers had continued to experience positive outcomes from their alternative solutions of ABU for at least two years, 2016 and 2017. Meanwhile, the remaining farmers (11, 44%) reported sub-therapeutic ABU for disease suppression because their solutions had not yet shown to be effective.

Among 56 farmers saying they were “not willing to reduce ABU” in 2016, some later reported that they were trialling alternative solutions to stop ABU for non-treatment purposes (18, 32.1%). These farmers intended to reduce ABU, but had not found reliable solutions yet. The remaining 38 farmers said “not willing” or have “no idea” about the effort to reduce ABU.

Overall, data showed three groups of 81 farmers representing three different types of responses to ABU reduction (Table 7.2).

Table 7.2 Categorizing farmers by intention to reduce ABU

Intention to reduce ABU	Practical ABU		Total
	For exclusive therapeutic	For both therapeutic & non-therapeutic	
Yes	14 (56%)[@]	11 (44%)[*]	25 (100%)
No	18 (32.1%)[*]	38 (67.9%)[$]	56 (100%)
Total	32 (39.5%)	49 (60.5%)	81 (100%)

[@] Pioneer farmers; [*] Hesitant farmers; [$] Conventional farmers

The first group included 14 farmers (17.3%) who showed both an intention to reduce ABU and effective alternative solutions. I would like to call them as ‘Pioneer’ who took part in the beginnings of stopping ABU as sub-therapeutic use and adopted alternatives to ABU for preventing diseases and stimulating animal growth. This group was characterized by those owning medium sized farms (9, 64.3%). These farmers also had a good understanding of ABU (12, 85.7%) and ABR (13, 92.9%). They also had median values of age and number of years of farming experience were higher than those in the other groups (Appendix - Chapter 7 - Table 1).

The second group (29, 35.8%) who had not yet found effective solutions for reducing ABU although they had made effort to stop sub-therapeutic ABU. I shall refer to these farmers as ‘Hesitant’ because they were in the process of making consideration between stopping and continuing the sub-therapeutic ABU. This group was characterised by those who were at a younger age and fewer number of farming experience years than ‘pioneer’ farmers. They owned different farm scales, from household to small and medium sized farms (Appendix - Chapter 7 - Table 1).
The third group were farmers who did not intend to reduce ABU and were practising sub-therapeutic ABU (38, 46.9%). I would call them as ‘Conventional’ because their farming relied on ABs for both treatment and non-treatment purposes. Similarly to ‘hesitant farmers’, this group also included younger farmers than “pioneer” ones and included those owning different farm scales (Appendix- Chapter 7 – Table 1)

7.4 Discussion

This chapter aimed to understand whether farmers paid attention to ABs related to information on the label of feed, their ABU on farms, and their intention to reduce ABU in the situation that Vietnam is on the road to ban ABU for growth promotion. The first finding is that farmers showed little concern about the presence of ABs in commercial feed although they were all using medicated commercial feed for their animals. Not many of them (44.4%) were aware of the presence of ABs and that was not the reason for them to choose feed. Instead, feed efficiency, which could be measure through rapid weight gain of animals, was the main reason for their selection despite the fact that the selected feed was medicated or not. Moreover, some farmers

pointed out the presence of ABs in feed was monitored by the government; therefore, they saw themselves not responsible for verifying or controlling ABs as growth promoters in feed.

The practice of supplementing ABs to medicated feed was reported by 49 study farmers (60.5%). At the time this study was conducted, in April 2017, the law still allowed the presence of ABs as additives in commercial feed for growth promotion (see Chapter 2). These facts indicated that the practice of adding ABs into feed at home by farmers had been already a common practice for disease suppression and growth promotion before the implementation of the ban (in 2018). However, very few farmers (12%) admitted that their ABU was as growth promoters (see Chapter Five). This result was in line with that in the study performed in Northern Vietnam, where only one percent of farmers reported their ABU for growth promotion (Pham-Duc *et al.*, 2019). Could this belief be a result of their lack of knowledge of ABU so that farmers could be aware of their ABU for growth promotion; or their concern about being judged due to practising growth promotion using drugs? This chapter does not have sufficient data to conclude which reason. However, it was noticed that between the period of 2015-2017, the issue of using growth stimulants in animal husbandry was very sensitive towards food safety (Nguyen-Viet *et al.*, 2017).

Furthermore, the ban of ABs as additives in medicated commercial feed may promote farmers' practices of adding more sub-therapeutic ABU for the reason of disease suppression. A lesson from Denmark showed that there was about 120% increase in the use of therapeutic ABs between 1998 and 2010 (DANMAP, 2012). Therefore, if there is a lack of law enforcement regulating ABU, the ban could promote non-prescribed

and self-administered ABs on farms (Alhaji & Isola, 2018; A. S. Chauhan *et al.*, 2018). Furthermore, unrestricted access to veterinary ABs could be seen as a driver for the intensive use of ABs (Boamah *et al.*, 2016; A. S. Chauhan *et al.*, 2018; Sadiq *et al.*, 2018). Consequently, these facts could undermine the efforts of the public health to ban AGPs for reducing the amount of AB consumption in animal husbandry. Also a lesson from Denmark shows that, to deal with this issue, the policy had enacted strict law enforcement for monitoring ABU. For example, the Danish Veterinary and Food Administration regulated threshold limits of average AB consumption for animal farms. If the threshold limits were exceeded, farmers had to pay a fine and other forms of punishment (Laxminarayan *et al.*, 2015). Farmers only accessed ABs by prescription of a veterinarian. To prevent a conflict of interest, Danish veterinarians have not had the right to dispense ABs since 1990 (DVFA, 2017). These could be lessons for Vietnamese policy makers considering and learning in efforts to enhance ABU stewardship.

The results indicated that the study farmers, generally, did not see their responsibility in verifying the presence of ABs in feed as well as the reason for stopping sub-therapeutic ABU for against ABR. Moreover, farmers in the Mekong Delta region were reported that they had a clear mindset of mitigating and dispersing production risk of animal diseases to protect their interest (Lan, 2017). Therefore, it could be quite difficult for them being willing to reduce ABU when poor law enforcement of ABU regulations provided them favourable conditions for using ABs as a "quick fix" to deal with animal diseases (L. D. Willis & Chandler, 2019).

Data of this chapter enable me categorizing the farmers into three groups according to their intentions and practices of ABU reduction for non-treatment purposes. These were 'pioneer'(14, 17.3%), "hesitant" (29, 35.8%) and "conventional' (38, 46.9%) farmers, showing that farmers had different dispositions towards ABU reduction. About half of the study farmers, including 'pioneer' and 'hesitant' farmers, had intention to reduce ABU although they did not share the same concern of public health related to the emergence of ABR. The data showed that farmers could be engaged in the efforts of public health to reduce ABU. However, the intervention approaches could be tailored to different farmer groups based on their different dispositions towards ABU reduction. Therefore, I believe that it is necessary to understand their motivations and values which drive their different intentions to ABU reduction.

7.5 Conclusion

Overall, farmers showed little concern about the presence of ABs in commercial feed, and they commonly added ABs into commercial feed for prophylactic and growth promotion purposes (60.5%). Efforts to reduce ABU through a ban of AGPs might fail because farmers could obtain ABs over the counter. Farmers did not share the same concern with public health towards the emergence of ABR and therefore, nearly half of them (38, 46.9%), namely 'conventional' farmers did not want to reduce ABU. However, the remaining half of them, including 'pioneer' (14, 17.3%) and "hesitant" (29, 35.8%) farmers had intention to reduce ABU for saving production cost, protecting animals from failed treatment because of ABR and preventing AB residue, showing the possibility of engaging farmers in efforts to reduce ABU.

Chapter 8

MOTIVATIONS OF FARMERS TOWARDS THE INTENTION OF REDUCING ANTIBIOTIC USAGE

8.1 Introduction

Among many dilemmas and decisions which farmers confront within animal farming, the practice of using antibiotics (ABs) on farms was the main topic in this analysis. In this chapter, I aim to identify and interpret motivations of 'pioneer', 'hesitant' and 'conventional' farmers in this practice to explore feasible solutions for engaging them in efforts to reduce antibiotic usage (ABU) against antibiotic resistance (ABR) for public health.

A literature review focusing on human behaviours provided some suggestions for the analysis. One of the first suggestions was from author W. Ashby, an English economist and social psychologist, in his article Human Motives in Farming, he wrote:

> "*If we want to know how or why a farmer acts in a certain way or how to induce him to act in a certain way, we have to enquire why men act, and especially why men act as they do when they live in the sort of social environment and general circumstances in which farmers live*." (Ashby, 1926)

In this statement, Ashby highlighted that to interpret farmers' actions, the study should focus on the reasons for their actions and the social environment in which farmers live. Also in line with this idea, Kurt Lewin introduced an equation to predict human behaviour and suggested that behaviour is a product of a person and his environment. In other words, environment affects behaviours (Lewin *et al.*, 1951). This is a process

in which farmers' behaviours are directed towards a desired end by their personal goals and inspirations and by their perception of the social environment including either resources or challenges which could promote or constrain farmers to attain their desired end (Gasson & Ruth, 1973).

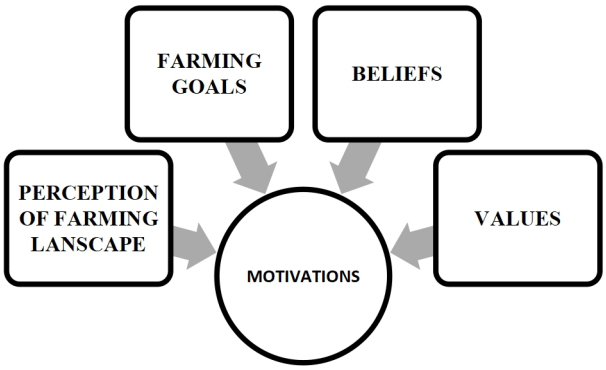
Regarding farmers' desired end or motives in farming, their choices and behaviours could be driven by different types of motivations decisions (Schoon & Te Grotenhuis, 2000). A farmer has his own concept of "*good farming that he wants to live up to*", including a set of beliefs and opinions which function as his "internal frame of reference". This frame provides an individual with rationality about their choices and practices, and is structured by the goals, beliefs and moral values of farmers decisions (Schoon & Te Grotenhuis, 2000). However, how could personal value be identified when value is an abstract concept that not everyone can express? A suggestion of Gasson and Ruth (1973) and then inherited by Parminter and Perkins (1997) was that farmers demonstrated their orientation of values through their farming goals. Goals and values are related and that interpreting underlying values from goals could be used as factors to predict or explain human behaviour and motivations (Eagly & Chaiken, 1993; Parminter & Perkins, 1997).

8.2 Methodology

To interpret farmers' practices and motivation, I will analyze farmers' perceptions on their farming landscape, the influences of these perceptions on their decision-making and practices (Gasson & Ruth, 1973; Parminter & Perkins, 1997; Schoon & Te Grotenhuis, 2000). The chapter will then go on to identify farmers' personal frames of

reference as internal drivers of their motivation towards different intentions to reduce ABU on farms. This will allow us to depict the portrait of each farmer group and to identify favourable and unfavourable conditions with which to engage them in efforts to reduce ABU. Fifteen farmers who represented the 'pioneer', 'hesitant' and 'conventional' farmers were invited to participate in the in-depth interviews to investigate the differences in their motivations and moral values.

Figure 8.1 Analysis framework to illuminate farmers' motivations



Interviews in the qualitative study were conducted in farmers' houses, where in three cases, either wives or husbands of farmers took part in the interviews along with their partners and added more information about their family's stories related to keeping animals. In these cases, informed consent was obtained from both people before the interviews. The structure of the interview guide included four sections to collect information related to farming goals, farmers' beliefs and perception about farming landscape, farmers' self-efficacy, and considerations. The main general questions were: why are you working in livestock farming, what do you think about livestock farming and ABU for animals, how confident are you in your decision-making in animal production, and who or what influences your daily farming decisions and practices

including ABU. Some of the probing questions are detailed in the interview guide (Appendix A-4). However, not all these probing questions were asked as the researcher expected farmers to share their personal views and stories to clarify their goals and values.

8.3 Results

8.3.1 Farmers' characteristics

Among fifteen participants, twelve of them were men, all had education between secondary school and undergraduate level, and their farming experience ranged from 9 to 29 years. All the farmers had small or medium-scale farms - keeping more than 50 pigs and/or 2,000 chickens (Table 8.1).

Pioneer farmers were characterized by all men, with older ages between 51 and 67 years old. These farmers also had the highest education level in comparison with farmers in other groups, with four of five farmers having an education level of high school or higher. One of them was a mechanical engineer with a bachelor degree. They were operating single animal farms keeping either pigs or hens. The majority of hesitant farmers were men. Their average age was quite young with 47 years old. They had education at the secondary and high school level. Except for one medium pig farm, they had mixed farms with small to medium scale. Among conventional farmers, there were three men and two women.

There was a range of ages in this group, between 34 and 69 years old, with a median age of 55. Their education level was similar to the hesitant group, at the secondary and

high school level. They were all operating mixed farms, with three small sized and two medium sized farms.

Table 8.1 Characteristics of farmers

		Pioneer farmers	Hesitant farmers	Conventional farmers	Total
Gender	Male	5	4	3	12
	Female	0	1	2	3
Age	Median (min - max)	57 (51-67)	47(39-62)	55 (34-69)	57 (34-69)
	<50 years old	0	3	2	5
	50-60	3	0	1	4
	>=60	2	2	2	6
Education	Secondary	1	2	2	5
	High-school	3	3	3	9
	Ungraduated	1	0	0	1
Years of farming experience	Median (min - max)	16 (9-24)	14 (11-19)	16 (13-29)	16 (9-29)
Farm size	Small	0	3	3	6
	Medium	5	2	2	9
Farm type	Chicken	3	0	0	3
	Pig	2	1	0	3
	Mixed	0	4	5	9

8.3.2 Farmers' perception about animal farming landscape

8.3.2.1 The farming landscape from farmers perspective: changes, advantageous conditions, and challenges

Changes from subsistence to commercial farming with advantageous conditions

All farmers from different groups perceived the major changes of animal production including an increase in farming scale, specialized farming and keeping animals as an occupation. Commercial pig and poultry farming was gradually replacing traditional backyard farming for household consumption. Farmers, these days, tend to keep one or two specific types of animals with intensive farming scale to ensure productivity and economic profits. Instead of free-roaming as before, animals in commercial farms are confined in houses to increase the density of animals and to facilitate care, thus animal houses suitable for each type of animal were built.

> "*Today if you raise one or two pigs as before, the production cost is so high and not profitable at all. It is cheaper and more convenient if you purchase pork from the market for household consumption. Raising livestock these days is mainly for income and economic profits*." *(A conventional farmer from a small sized pig farm)*

According to these farmers, the growth of livestock and poultry production was a result of the availability of commercial feed, technical support from vet-drug companies, and the improvement of rural transport infrastructure. All these factors were stimulating the growth of intensive animal husbandry. Commercial feed was beneficial for promoting animal growth, shortening the raising period, and saving labour time. For instance, raising pigs from piglet to slaughtering only took farmers about five to six months in

comparison with twelve months if feeding animals by agricultural by-products such as paddy rice, maize or kitchen waste, which farmers used to look for and make use of. Thus, one to two family members could potentially take care of up to 20,000 chickens or 200 pigs at the same time. As a result, instead of just taking advantage of leisure time to get involved in taking care of animals as before, farmers currently work on farms as their fulltime job and a means for earning income (Appendix- Chapter 8 – Table 1).

This story of a 62 year-old female farmer typically illustrates the transition of farming from subsistence to commercial:

> *"When I was young, I kept one or two pigs in the backyard, mainly for the Tet festival (Lunar New Year). At that time, I was a teacher at primary school and my husband was a mason. Before and after work, I cooked rice and vegetables for the pigs. Doing that was enough to care for pigs, nothing else was needed. If we were lucky, the pigs could weigh 70 or 80 kilograms each after 10 to 12 months. Then, we usually slaughtered one for household consumption and sold the other to save money. If we were unlucky, there was no Tet holiday for our family. Several years later, I quit my job due to low salary and being too busy with my children. I stayed at home and focused on raising pigs. Initially, we built one cement pen right behind the kitchen, keeping only one sow and two fattening pigs. A few years later, we had two and then three pens. Now, we have nine pen for sows, two sty-floors for sows and their piglets, and eight pens for fattening pigs. In total, our farm can keep a maximum of 200 pigs at the same time. My husband also quit his job a few years after me to raise pigs with me. Thanks to pigs, we can send our*

children to university, and now they have stable jobs in the city." (A pioneer farmer's wife from a medium sized pig farm.)

A few farmers from each group mentioned the development of rural transport infrastructure. The manifestations of rural transport development included the expansion of rural roads, the replacement of dirt paths with widening concrete roads, and the replacement of small wooden bridges with solid concrete ones. For example, vans are a common transportation means of transportation in rural areas these days. It is more convenient for farmers to transport pigs or chickens to slaughter in vans than using motorbikes or other rudimentary vehicles as before. It also saves time and reduces animal stress and loss.

Challenges from the growth: animal diseases, inconsistent practices and unstable market prices

With the growth of commercial farming, farmers indicated two challenges they were facing. These were controlling animal diseases and managing production cost. All studied farmers shared the thought that livestock and poultries were more susceptible to diseases than before, although they had better care. Farmers described the high incidence of animal diseases that could potentially develop into an epidemic, causing rapid loss of animals. Moreover, they experienced that animals could contract more than one disease at the same time, causing more complicated symptoms making it harder for farmers to practice their habit of self-prescription.

They reasoned that this problem arose from both inside and outside their farms. The higher density of animals on farms led to challenges of waste management and also

managing the transmission of pathogens within farms. These challenges came from limitations of farm facilities which were not completely adapted to the requirements of intensive farming. For example, they could not adopt an "all-in all-out" system on their farms because their animal houses were not built all at one time, but gradually depending on their economic conditions or available land areas. Therefore, according to these farmers, it was not easy for private farms to have ideal settings for intensive farming. In addition, factors from outside their farms include differing farming practices among private farms within the community that could exacerbate environmental pollution and the emergence of animal infections. They described the poor hygiene practices of neighbouring farms which cause concerned about the spread of infections through air or water flows.

> *"When the chickens were sick and then died en masse, they (nearby farmers) did not inform us. The dead chickens were thrown into the ponds or scattered around by the dogs everywhere within that farm. I just know how to keep my farm clean, how can I interfere with my neighbour's farm which is just a fence away from my farm? At that time, I was so worried that pathogens would threaten my animals."*
>
> (A conventional farmer from a medium sized chicken farm)

Regarding production cost, the challenges came from unstable market prices for both input costs and output products. Farmers estimated that feed accounted for 70% of input costs while the remaining 30% was shared among other input costs such as farm facilities, breeding, veterinary drugs and services. No one mentioned labour cost in this calculation. They were concerned about the unstable prices of input costs and finishing animals which, according to farmers, were determined by the market and out of their

capability to interfere. Although the cost of veterinary drugs and services accounted for only about 10% of the total production cost, they were very important to prevent animal loss and ensuring good productivity. It was also the only cost farmers thought that they could manage through their individual efforts to control animal diseases.

8.3.2.2 Farmers' responses to their perceived farming landscape

Highlighting learning for improving self-efficacy

The common thought shared by all study farmers was that raising animals these days requires technical advancements, not only basing on past experience as before. Thus, they believed they needed to learn and update their farming knowledge and skills to improve their capability in caring for animals. This improvement could be beneficial for them to perform the common tasks on farms such as daily feeding, cleaning, sanitation, doing vaccinations, basic treatment for animal diseases, or even offering farrowing support for sows without hiring veterinary services to help reduce the production cost.

Various sources of information are now available to farmers on how to approach and improve their farming knowledge and skills. This information was not available to them before. The farmers, especially pioneer farmers (all five people), believed this was advantageous for them and could help them to improve their self-efficacy. These information sources could be disseminated through training programs on television or local training events organized by provincial sub-department of animal health and husbandry. Farmers who were the customers of vet-drug companies had the chance to participate in training workshops funded by these companies as a kind of post-sale service. Information provided by these training events included farming techniques,

performing vaccinations and disinfection, and controlling animal diseases. These farmers were more impressed with training workshops because these events provided them opportunities to communicate with and consult experts about any information they wanted to learn.

> "*Each workshop is often combined with talks or pieces of training from experts about specific diseases, then they will introduce their products for preventing or treating those diseases. Of course, these are for advertisement purposes. However, it provides knowledge for us. It is very helpful. Whenever they invite us we always take part*." (A pioneer farmer from a medium sized pig farm.)

A belief in "a game of chance" responding to uncertainty

For some hesitant and conventional farmers, learning to improve their self-efficacy and relying on veterinary drugs was not enough to eliminate their belief in "a game of chance". They responded to the question of challenges in dealing with animal diseases with answers about uncertainty about loss and gain in the decision-making process. The outcomes sometimes went beyond their calculation or estimation.

> "*The outbreak of foot and mouth disease (FMD) this year did not enter my farms, while in contrast it caused severe damage to almost all farms in this community. I was very lucky with injecting an appropriate vaccine for my pigs. I say that because at first I could not buy the vaccine sold by the service centre of animal health and husbandry. Many orders were placed before mine. Very worried, I called my nephew and he introduced me to another type of vaccine, also for preventing FMD, but it was different to the type sold by that center, where I*

always trust the vaccines they sold. However, because I had no other choice and it was very urgent, I bought this type of vaccine, although I was not sure about this choice. Luckily, the vaccine I bought prevented the type of FMD this year while the vaccine sold by the center did not. I thought I would have to close my farm due to the outbreak of FMD this year, after the severe loss of more than 800 million dong (~$ 34,000) in the last year due to the collapse in the price of finishing pigs" (A conventional farmer from a pig farm.)

In some cases, farmers could not apply their previous experience to determine their next decision because of their uncertainty. They relied on their intuition to make decisions and participated in "a game of chance".

"The last outbreak of foot and mouth disease did not cause serious loss to my farm. Just on the sixth day of the last Tet holiday, I called the merchant and sold him 32 pigs with the price of 5.5 million dong per 100 kg. My neighbour advised against selling the animals but to wait until the middle of January when he believed the price would be higher. And he did that. Because I was so worried about the outbreaks, I decided to sell my pigs in the end. In total, my interest was 32 million dong, it was better than nothing if my animals got sick. I recognize that my decision was lucky when one week later, the price dropped to 3.8, and then further to 3.2 million dong per 100 kg." (A conventional farmer from a medium sized pig farm.)

In both these cases, farmers had to make decisions in urgent situations in which they did not have many choices. They were uncertain about the results of their decisions.

However, the way they made their decisions aimed to mitigate the potential loss due to animal diseases or market collapse rather than to maximize their profits.

Efforts for fostering cooperation among private farms to improve their power and competence on the market

Some pioneer farmers mentioned efforts to promote cooperation among private farms to deal with environmental pollution, animal diseases and poor competitiveness. They were aware that running private household farms caused them not be able to directly negotiate over the price with both material suppliers and processors, but via middleman-systems which made the decisions for market prices. They expected that cooperation among private farms would lead to have consistent farming practices, including the same procedures, techniques, or strategies in dealing with animal diseases and environmental degradation. This cooperation aimed to improve farmers' power and competence on the market and also to minimize the roles of intermediaries, which could reduce farm profits.

Overall, farmers' perceptions about the farming landscape showed unfavourable conditions for efforts to reduce ABU among the studied farmers. They perceived infections among animals as the main challenge during the shift from smallholder farming for subsistence purposes to intensive commercial farming. Their response to this challenge was active learning to improve self-efficacy in making diagnoses and reliance on vet-drugs for self-medication. They defined the availability of commercial feed and vet-drugs and the technical support of vet-drug companies such as recommendations for farming procedures, or training workshops, as a favourable factor

in their response. However, the more they participated in the training workshops organized by vet-drug companies, the more they used ABs for sub-therapeutic purposes for their animals (see Chapter Five).

The difference between pioneer farmers and other farmers was seen in their response to the challenges of animal infections and market fluctuation. While hesitant and conventional farmers were struggling with uncertainty in making decisions and making personal efforts to manage their risk, pioneer farmers recognized the need for cooperation among private farms to unify their farming procedures and commit to environmental protection for fostering farming growth and improving competitiveness (Appendix B- Chapter 8 - Table 1).

8.3.3 Farmers' personal frame of reference

8.3.3.1 Farming goals – reasons for farming

Each farmer referred to more than one expected outcome from livestock farming, and multiple farming goals (Table 8.2). These goals were categorized into five groups: production, income, personal circumstances, autonomy, and lifestyle.

Production: Pioneer and hesitant farmers mainly aimed for high economic value of products. Therefore they aimed to produce the highest quality products and enhance valuable livestock farms to expand the market. This goal was not mentioned by conventional farmers who expected the stability of both product price and final profits.

Income: Apart from one chicken farmer (a pioneer farmer), all farmers said they chose to work in agriculture for economic reasons. Pioneer farmers were those of an elderly age and they did not have dependents at home. Therefore rearing animals was a means

to provide them with an income. In contrast, most of the hesitant farmers, who were younger, still had dependents and children at home to financially support and provide an education. Therefore, they were more reluctant to change their current farming practices, including reducing ABU which they considered as increasing the risk of animal diseases and poor productivity. Meanwhile, conventional farmers were a cohort who were either working for personal or household income.

Personal circumstances: Farmers mentioned age-appropriate work, health-appropriate work and having no other job opportunity as reasons for choosing to work in livestock farming. Age-appropriate work was mentioned by older farmers, who started to keep livestock animals after their retirement. Health-appropriate work was mentioned by a middle-aged woman in the hesitant group who thought that farming was suitable for her poor health conditions. There were six cases, equally divided equally between the three groups, who admitted that working on livestock farms was their traditional occupation, which they had engaged in from a young age.

Autonomy: Farmers were motivated to work in livestock farming by an expectation of flexibility in time management, "being their own boss", and being economically independent. Farmers who emphasized the autonomy of time management were younger, especially women, who wanted to utilize the flexible working time of household farms for doing housework and taking care of their family while still having an income. "Being my own boss" was mentioned by male farmers from the both the pioneer and hesitant groups. Being economically independent was highlighted by elderly farmers, mostly in the groups of pioneer and hesitant farmers, who expected to earn an income for themselves.

Lifestyle: Working in livestock husbandry for fun or for living an exciting life was only mentioned by pioneer farmers. Only one farmer engaged in chicken farming for his pleasure because he was not under economic pressure: "*After retirement, I raised chickens, a thousand heads, for fun. I believe I will be healthier if I am working on farms. I do not keep chickens for money*" (a pioneer farmer from a medium sized chicken farm). This farmer was an engineer who previously had his own business offering logistic services and animal feed. Before having a chicken farm, he spent more than ten years providing technical support to other livestock farmers as his customers. Therefore, he understood livestock farming, including its advantages and challenges. This farmer, together with other pioneer farmers, talked about how exciting life was with novelty and challenges. These farmers showed their pleasure of exploring technical innovations to overcome the limitations of household farming and being willing to share these initiatives with others. They also made effort to create the connection among farmers, aiming to achieve a commitment about the same quality of farming management and to increase farmers' power and voice within the market flow. Overall, this description shows that farmers' desired outcomes of livestock farming was not only income, but also other things related to their personal reasons and ambitions for the growth of this sector. These desired outcomes could influence their intention to reduce ABU on farms.

8.3.3.2 Farmers' values - taking care of animals, sub-therapeutic ABU, and ABU reduction

Humanity and sensitivity in taking care of animals: different approaches to determine sub-therapeutic use ABU

A common characteristic seen in all studied farmers was their effort to take care of their animals well. They saw the connection between disease prevention and economic efficiency, and that "*if we do our best for the animals, they will repay us the best".* To farmers, taking care of animals was not only feeding them or doing disinfection on farms, but also frequently observing the interactions between animals, their physical condition, and their attitude to recognize their health status. All farmers made efforts to understand their animals so that they could notice differences in animal behaviour to detect any signs of illness or unwellness in animals, showing that farmers paid more attention to animal disease prevention.

> *"Every day, I go around the cages and look at their feathers, combs, eyes or even droppings to know whether they have any sign of illness. It is not so complicated to identify which ones may have problems. Then, the one who shows sign of being unwell will be marked by pen on their feet and on their cages."* (A pioneer farmer from a medium sized chicken farm.)

Farmers also showed their humanity and sensitivity in taking care of animals when they treated their animals as if they had souls. They used human traits to describe their pigs, such as active or quiet, friendly or cold, naughty or well-behaved. The language they used with the pigs was similar to the language they used for their children. They tried to avoid using words such as sick or illness on their farms since they believed saying these worlds could bring bad luck to their animals. Instead they said "*this pig is asking for*

coddling" to imply that the pig was not as healthy as he normally was and needed more care. Some farmers said that "*animals are like people*" since they felt uncomfortable due to crowding, heat or poor hygiene.

> *"Just looking at their faces, I understand what they want. Sometimes they give me their "puppy eyes". I know they feel unwell and need me to care for them more. They are not different from humans at all, they also have coughs and runny noses like us. I just take care well of them like I take care of my children.'* (A conventional farmer from a medium sized pig farm.)

Sometimes, they used their own "humanistic reasons" to justify their practices of treating animals as solutions for promoting animal health.

> "*I usually do not separate piglets from their mothers as soon as other farmers do, let's say one month. I have different ways for weaning management. It doesn't matter if it's one or two months, I let them breastfeed until I see them grow well enough, and scramble for bran with their mum, meaning that they are ready for the separation. You see, they show their happiness when living with their mum. Although prolonging the breastfeeding period increases the production cost, such as continuing to provide nutritious food for sows, or delaying re-breeding with them, I believe it's worth it to do that. The piglets are more healthy and less likely to be ill."* (A conventional farmer from a medium sized pig farm.)

In addition, they also tried to reduce their animal's anxiety and stress. For example, they built a steel fence around the farm to prevent dogs or cats entering, they tried to not speak too loudly, they wore clothes with the same colour so the chickens could get familiar with it; or they prevented any strangers from entering the farm, and they

located their bed near to the pen to look after the sows at night. These common practices were seen in almost all the study farms, showing that they were trying to care for and protect their animals with what they thought was the best.

However, regarding the practice of sub-therapeutic ABU for disease suppression, there was a split among these groups of farmers towards the role of this practice in animal production and their concerns about its harms and benefits. Pioneer farmers saw its harm in later treatments due to drug resistance. In contrast, hesitant farmers and conventional farmers perceived it as the solution for disease suppression, although hesitant farmers were also concerned about the presence of AB residues due to long periods of giving ABs at low concentration to animals.

Pioneer farmers shared the view that: "*No one can understand animals like us. We do everything that's best for our animals. Relying on antibiotics for disease prevention is not good for animals. Your animals will suffer more pain and stress due to prolonged treatment duration for infections because some kinds of effective antibiotics are not effective anymore.*" (A pioneer farmer from a medium sized chicken farm)

While in contrast, conventional farmers said: "*If you wait until your animals get sick and treat them with antibiotics, your animals may at that time not recover any more. They could have stunted growth because of a high drug-dose for treatment. They are very pitiful."* (A conventional farmer from a medium sized pig farm.)

In contrast to other groups, hesitant farmers were in a dilemma: "*I have tried to stop using antibiotics for routine prevention to prevent antibiotic residues. However, after that, my animals frequently get sick and very sick because of infections. Then, I use*

sub-therapeutic dose again for the next flock of chickens." (A hesitant farmer from a medium sized chicken farm.)

Overall, continuing to use sub-therapeutic ABU or stopping the practice was partly driven by farmers' humanity and sensitivity in taking care of their animals and farmers' perception towards potential harms or benefits of this practice to their animals.

Sub-therapeutic ABU: potential harms, relevant stakeholders, and self-efficacy towards antibiotic reduction

Pioneer and hesitant farmers were more concerned with the harms of ABU to animals, human health and farming efficiency than conventional farmers. With regards to animal health, a common belief, which was mainly shared by pioneer farmers, was that sub-therapeutic ABU was not beneficial for animal production.

> "*If you always rely on antibiotics for disease prevention, when diseases happen, antibiotics might be not effective anymore because your farms have become resistant to such antibiotics. At that time how can you deal with infectious diseases among animals if such antibiotics are no longer effective?*" (A pioneer farmer from a medium sized chicken farm.)

Then, the consequences were not only an increase in treatment cost, but also high mortality in animals, which threatened farming productivity and economic benefits to farmers. Furthermore, these farmers, along with hesitant farmers, showed their concern about AB residues as the potential consequence of sub-therapeutic ABU threatening health matters of animal food consumers who could be their families, relatives or even themselves.

When farmers saw themselves in the position of customers, they perceived that the requirement of fresh and safe food products to protect their health, and that of their relatives, highlighted their obligation to produce safe animal food products (Verbeke & Viaene, 2000). This became an internal motivation as their moral conscience drove their behavioural intention to conduct harmless actions to others (Giubilini, 2016). As a result, these two groups of farmers had the intention to stop sub-therapeutic ABU.

> "*If you go to the market and purchase meat, how can you know whether such meat is from which farm? I just think if my children or relatives, who are in the city, could purchase meat from my farm, how terrible if my farm provides them with unsafe meat. Thinking about that, I remind myself that I have to produce safe meat. It is not important to have more income from the farm if I destroy my relatives' health."* (A hesitant farmer from a medium sized pig farm.)

However, the differences between the two groups of farmers were seen in their ethical norms and self-efficacy towards the alternative solutions. Pioneer farmers believed the right things to do were their responsibility and competence to produce the highest quality of animal products. They talked about their commitment and desired outcome of producing food animals.

> "*We are confident that there is not any chemical or antibiotic residue remaining in our farm products. That is our commitment and goal. We use eggs produced from our farms because we know how they are produced and how fresh and safe they are."* (A pioneer farmer from a medium sized chicken farm.)

They showed their enthusiasm in finding alternatives through exploring, learning about, and testing various solutions such as making efforts to get rid of fly-larvae to prevent

sources of infections, using herbal ABs, or strict compliance of choosing good breeds, adopting a vaccination schedule, managing waste and keeping farms in good hygiene conditions. The following quotation represents the experimental process of one farmer who tried to find a solution for killing fly-larvae on his chicken farm for preventing infections to animals.

> *"Raising chickens brings a lot of flies. The flies are vectors for transmitting diseases and causes chickens to be uncomfortable. Furthermore, the more diseases chickens have, the more antibiotics they consume, and the consequence is wet manure, which in turn makes it easy for flies to grow on the farm. I have tried many ways, from spraying insecticides to pesticides, anything that I learned from others including specialists I met in the workshops, vets, and friends. However, these solutions were not only ineffective but also harmful to my animals. Then, I thought, to kill flies, we should kill fly-larvae instead; no larvae means there will be no flies. I've read somewhere that larvae grow well from absorbing nutrition from wet manure. I could stop this growth by spraying bio-probiotics formed from the fermentation of glucose. The litter and bedding material become drier, and no larvae can survive. Now you can see, there are no flies on my farm anymore."* (A pioneer farmer from a medium sized chicken farm)

Generally, these farmers did not apply a new solution suddenly, but went through a process of trial and error with failures and adjustments before being confident with its effectiveness.

> "*It is not an easy thing if you want to replace antibiotics with alternatives, such as herbal antibiotics. I should try many times with several small flocks before*

applying to the whole farm. I make a decision based on the comparison between the trial flocks and the normal ones. Then I adjust the amount used to be more effective. I have never solely followed the guidance from the sellers." (A pioneer farmer from a medium sized chicken farm.)

Hesitant farmers showed their intention to exclude sub-therapeutic ABU as their moral obligation to produce safe animal products to serve consumers. However, they had not found effective solutions yet, so they were not confident in realizing their intention. That was a reason why some of them were seen only using ABs for treatment one year ago, but the next year they implemented sub-therapeutic ABU again due to experiencing failures, affecting productivity and income after efforts of reducing ABU in the past. One of the reasons that made them hesitant to change was that any change could cause income loss and subsequently put their dependents at risk. These farmers were "breadwinners" for their families, keeping livestock animals for household income, not for individual income. The difference in resilience between the two groups of farmers could be seen. While pioneer farmers, owning medium single animal farms, had the capability to recover quickly from failures and continue their trials, hesitant farmers were struggling with many limitations of financial conditions, facilities or land size to actualize their intentions. Therefore, any experiences of negative outcomes would cause them to be more cautious to change.

"*I have tried to apply biological pads for the piglets then stopped using antibiotics for prevention, but it is not effective at all, I lost more than 10 piglets. I think it's better if I improve the farm facilities to be more ventilated and improve waste management to reduce pollution related with farms, but I couldn't*

implement these improvements because of their high cost and the unstable price of finishing pigs." (A hesitant farmer from a small sized pig farm.)

Table 8.3 Farmers' beliefs about sub-therapeutic ABU

Aspects of consideration	Pioneer farmers	Hesitant farmers	Conventional farmers
Potential harms of sub-therapeutic ABU	• Creating toxins to animals • Resulting in stunted growth and "being resistant" to further treatment courses for animals • Increasing treatment cost and mortality rate • Causing AB residue threatening consumers' health		• None. • Sub-therapeutic ABU is necessary.
Stakeholders	• Animals • Consumers	• Animals • Consumers • Farmers & Household members	• Animals • Farmers & Household members
Alternatives to potential harms	Stopping sub-therapeutic ABU	Intention to stop sub-therapeutic ABU	None
	Being confident with alternatives to ABs	No effective solutions for reducing ABU	Sub-therapeutic ABU prevents animals from potential pain and loss
Ethical norms	Responsibility and competence of farmers in producing the highest quality animal products	The obligation towards consumers' food safety	Farmers' success shown in good productivity

Conventional farmers supported regular sub-therapeutic ABU, which was believed to have no potential harms but benefits for farm productivity and animal health. The common argument among these farmers was that by conducting active disease prevention with ABU, they would prevent animal pain and loss. Some of them highlighted the right of animals to be kept healthy and cared for as the duty of a farmer. As a result of that, animals growing well and obtaining high productivity showed their success in farming, resulting in income and economic benefits. In addition, it was also beneficial to consumers who would consume products from healthy animals at the finishing stage. These farmers believed that they were using ABs in a "considered manner" and did not want to change their current practice of ABU (Table 8.3).

> *"I always treat my animals with antibiotics when it is necessary to deal with animal diseases. I believe that an overuse of antibiotics is not good for pigs."* (A conventional farmer from a small sized pig farm.)

8.3.4 An overview of pioneer farmers, hesitant farmers and conventional farmers

Overall, all farmers showed their efforts to take care of their animals well with a sense of humanity and sensitivity. They did the best for their animals. However, they had different perspectives towards the benefits and harms of sub-therapeutic ABU through the practices of adding ABs into feed to justify their responses (Chapter Seven). Among their concerns and considerations, they mentioned the possibility of ineffective treatment due to ABR, AB residues threatening consumers' health, or animal infections threatening productivity. However, none of them mentioned their concern about ABR

with the spread of multi-resistant bacteria that could cause infections that are untreatable with existing AB medicines. I categorised the fifteen farmers into three groups based on their attitudes: 'pioneer', 'hesitant' and 'conventional' (see Chapter Seven).

Pioneer farmers

These farmers were the first to make efforts to reduce ABU on farms by stopping the sub-therapeutic ABU for food animals. They were characterized by owning medium sized, single animal farms keeping either chickens or pigs and having good experiences, knowledge and farming skills. They showed a well-formed perception of the farming landscape including changes, advantages and disadvantages. They were also active and more open in interacting with various supporting sources and utilizing them as opportunities for improving their self-efficacy in handling their farms. In addition, they showed confidence in their alternatives, which they had experienced the success and effectiveness of. Their farming was mainly driven by their own motivation and lifestyle to take challenges as their farming goals. Their ambitions were not only about basic economic profits, but also about providing the highest quality livestock products for the public and to increase the value of livestock farms. Their value orientation went beyond economic concerns, consistently focusing on ideals and moral convictions about their contribution to the social benefits and the sustainable development of the livestock sector.

Hesitant farmers

Hesitant farmers believed that stopping sub-therapeutic ABU was the right thing or their obligation to produce safe animal products not containing AB residue. They were

in a trial process to find out effective alternatives. Some of them experienced failure and economic loss from the trials. However, with owning small and mixed farms, and limitations of financial conditions, facilities or land size, these farmers found it difficult to recover after the failures, causing them to be more cautious to avoid potential mistakes that could harm their household economics. Under the pressure of productivity and economic benefits, these farmers were struggling to find feasible solutions to adopt as alternatives to sub-therapeutic ABU and considered their uncertainty about loss and gain in their decisions.

Conventional farmers

Conventional farmers did not have motivations for AB reduction because they saw the necessity of sub-therapeutic ABU and did not think this use was inappropriate. They hold the belief that they had used ABs in a "considered manner" and did not want to change their habits. They tended to rely on their own experience to make judgements about the right course for animal management. They relied on sub-therapeutic ABU practices as a solution for active disease suppression. Their common thought was that prevention was better than treatment, not only for avoiding animal loss, but also for the welfare of animals and the subsequent benefit to consumers. This group was likely to be resistant to adopt alternatives to ABs because of the perceived effectiveness of their current farming and their perception of the "real threats" from the alternatives to ABs as sub-therapeutic use.

8.4 Discussions

This study aims to interpret farmers' motivations for using and reducing ABs through an analysis of the perceptions of farming landscape and personal frames of reference among three groups of farmers who had different responses to sub-therapeutic ABU practices.

Generally, there were asymmetrical concerns between AB residue and resistance as the factors related to ABU in pigs and poultries impacting human health. Generally, farmers with different predispositions were concerned about AB residues, toxins causing poisoning, and food safety more than the risk of ABR to public health. These farmers were unlikely to be aware of the relationship between AB residues and resistance, in which AB residues in food animals could be transferred into ABR in humans due to the mobile properties of resistance (Bacanlı & Basaran, 2019). This finding was consistent with results shown in the previous analyses that farmers had less understanding of ABR and its particular impacts on human health (Chapter 5 and 6). It implied an existing limited knowledge that needs to be improved through intervention programs to build farmers' appropriate awareness and commitment to combating the threat of ABR.

These results of the study also indicated that although animal production was considered an economic sector, farmers were not only motivated by economic factors but also by other non-economic ones, such as the consideration of household income for dependent members, animal health and being well-taken care of, obligations to consumers' health, and ambitions to contribute to the sustainable development of the animal husbandry. Farmers might earn income either for themselves or for the welfare

of their families. Similarly, when farmers highlighted their duty to animal welfare, they also targeted their economic benefits since, to farmers, good animal welfare was defined as keeping animals healthy, resulting in highest productivity and economic benefits. This finding was consistent with the idea that a farmer did not make decisions and choices based on a single line of reasoning (Schoon & Te Grotenhuis, 2000). Underlying economic motivations could be other non-economic ones, implying that a farmer could not be considered as a basic economic person, whose decisions and practices solely aim to maximize economic profits (Edwards, 1991). Moreover, data of this study show that the farmers had different responses to sub-therapeutic ABU practices, basing on their own values. Pioneer farmers were pursuing the values of responsibility and competence to produce the highest quality of animal products. Hesitant farmers highlighted the moral obligation to produce safe animal products to serve consumers. To conventional farmers, their values were humanity and sensitivity in taking care of animals.

The study farmers did not mention financial limitations as one of their current challenges, although they were aware that investing in and improving facilities would be an effective solution for disease control and AB reduction. It was likely to be a paradoxical response when financial capital was often the top issue in discussing economic behaviours of producers. However, this paradox could be understood if we connect this response with the historical and socio-economic characteristics of farmers in the Mekong Delta region. Although agricultural farmers in this region tended to develop commodity economy long ago in the region, their economic response was in favour of conditional profit maximization and risk mitigation (Đồng, 1995; Ellis, 1993;

Lan, 2017). This was because they were aware of the limitations of markets and the socio-economic environment (Quang, 2018). For example, an unstable market together with animal disease risk, increased their economic risk and at the same time farmers did not have any subsidy from agricultural sectors or agricultural insurance. Therefore, although they desired to improved their farms, they did not want to risk investing capital in improving farm facilities as it was not deemed to be an urgent need.

Overall, my study has shown that to engage farmers in efforts to reduce ABU, multiple intervention strategies are required in order to be approach different types of farmers. Strategies may include utilizing available resources from pioneer farmers and farming communities for promoting behavioural changes. It could also be a combination of education to increase knowledge or understanding related to ABU and ABR, training to impart farming skills for disease suppression without sub-therapeutic ABU, restructuring the physical farming environment to stimulate the change, and creating regulations and guidelines for practice standards (B. F. Chauhan *et al.*, 2017). Specific suggestions for interventions to target each groups are included in the final discussion chapter.

8.5 Conclusion

Overall, all fifteen pioneer, hesitant and conventional farmers perceived the major changes of animal production related to the growth of intensive farming for commercial purposes. They were also aware of the challenges from the growth of this sector related to animal diseases, inconsistent practices and unstable market prices. Except for their perception about the necessity of learning for improving self-efficacy, farmers from

different groups had different responses to their challenges. Pioneer farmers showed their confidence in their alternatives to ABU for sub-therapeutic purposes and ambition to foster cooperation among private farmers to improve their power and competence on the market. In contrast, the other farmer groups showed their uncertainty about loss and gain in the decision-making process, including ABU on their farms.

My study indicates that although farmers are living in the same farming landscape, their intention and practices on ABU had distinctive characteristics and heterogeneity. Their perception of the landscape, farming goals, beliefs and values were based on their living conditions and their current knowledge of ABs, ABU and ABR. Therefore, any interventions aiming to change their behaviour should take into account their personal characteristics of capacity, circumstance and needs.

Furthermore, it became obvious that the intention to reduce ABU in livestock animals was driven by both economic and non-economic motivations. Farmers should not be considered purely as economic men because they also considered moral values in making decisions. These values were responsibility and competence to produce the highest quality of animal products (pioneer farmers), moral obligation to produce safe animal products to serve consumers (hesitant farmers) and humanity and sensitivity in taking care of animals (conventional farmers).

Chapter 9

DISCUSSION AND CONCLUSIONS

9.1 Discussion

The rapid emergence of antibiotic-resistant microorganisms was identified as one of the greatest challenges for global public health (O'Neill, 2014; Robinson *et al.*, 2016; WHO, 2010, 2015b). Since the emergence of antibiotic resistance (ABR) is related to the human behaviours of making decisions about antibiotic use (ABU), it becomes a social problem which requires social solutions based on a greater understanding of human perceptions, practices and motivations (Smith, 2015). This study aimed to explore farmers' perceptions on ABU, ABR and their motivations for ABU in farming practices. The results showed potential favourable and unfavourable conditions for the efforts to reduce ABU on animal farms.

The results of the study reveal that smallholder farmers' understanding about ABU (87, 87%) and ABR (77, 77%) was still limited, and that they had a limited sense of the health risks from ABR microbial and zoonotic infections. Although farmers self-evaluated that they used ABs in a "considered manner", their ABU on farms was inappropriate with the common practices of sub-therapeutic ABU (57%) and self-prescribing medication for their animals (76.9%). Although the farmers were interested in learning farming techniques and skills to increase their self-efficacy on farms in order to promote effective farming production, the more they took part in these events, the more they used ABs for sub-therapeutic purposes. Despite raising pigs or chicken for income, farmers' practices on farms were not only driven by economic motivations but also non-economic ones. Their non-economic motivations were concerned about

ambitions to produce the highest quality of animal products contributing to the sustainable development of the sector (pioneer farmers), obligations to consumers for food safety (hesitant farmers), and the humanity and sensitivity in taking care of animals (conventional farmers).

Overall, the study results show unfavourable conditions for efforts of the public health to reduce ABU because of farmers' limited understanding of ABU and ABR, the untrusted relationship of farmers to veterinarians, and the poor law enforcement of ABU stewardship.

The farmers were not aware that the development of ABR threatening public health, including their own health, could be associated with their ABU for food animals. Results from another study in the Mekong Delta region provided evidence that farmers and local residents carried colistin-resistant bacteria which likely originated from farms where colistin was used for chickens (Trung *et al.*, 2017). Farmers could be at high risk of ABR infections due to their high exposure to AB residues in the farm environment, such as through animal waste, air or dust (Ben *et al.*, 2019; Trung *et al.*, 2017). However, I found that farmers were unlikely to share the same public health's concerns about ABU and ABR. Their lack of understanding of these issues resulted in inappropriate ABU practices on farms, despite the fact they thought they were using ABs with consideration. Farmers were also unaware of the relationship between AB residues and resistance, in which AB residues in food animals could lead to the emergence of ABR microorganism in humans, including farmers, due to the mobile properties of resistance (Bacanlı & Basaran, 2019). The results were in line with those from a pilot study in South Carolina reported that most dairy farmers (86%) were not

concerned about ABR as a result of overuse of ABs for animals, and studies in Spain and other EU countries about pig farmers, who were also unaware of these issues (Moreno, 2014; Visschers *et al.*, 2016). These findings show that the lack of concern about the harmful effects of ABU on public health is a common problem worldwide and counters global efforts to reduce ABU in food-animals. This problem occurs in both low-middle (LMICs) and high-income countries (HICs). However, the emergence of ABR will be more urgent in LMICs, such as Vietnam, where farmers still retain inappropriate practices due to their concern about animal diseases.

The common belief of many of the farmers (89%) was that ABU was a major solution to protect animal health. This belief indicated that ABs were considered as a "valuable cost-effective tools for animal health and husbandry" or a "quick fix" to solve their concerns about productivity and income (Moreno, 2014; L. D. Willis & Chandler, 2019). It could be a consequence of an important transitional stage occurring in animal husbandry in Vietnam, shifting from backyard farming for subsistence purposes to intensive farming for commercial ones (AJICA, 2013). This movement was consistent with the State's orientation, which was to gradually increase the scale of livestock and poultry production to supply the domestic market and for export (Decision 10/2008/QĐ-TOT, issued in 2008). However, since keeping chickens and pigs is a traditional occupation for many rural households, during this transitional stage, smallholder farms still dominate, accounting for more than 70% of total animal farms and contributing to 30% of total animal products (GSO, 2016b). The rapid growth of intensified smallholder farming was exerting massive pressures on the environment, resulting in different types of pollution and animal diseases (OECD, 2015; Tung, 2017).

Consequently, as shown in this study, all farmers were using ABs for either therapeutic or non-therapeutic purposes, especially without professional veterinary advices and poor law enforcement of ABU regulations.

The untrusted relationship of smallholder farmers to local veterinarians could exacerbate inappropriate ABU on farms. A high proportion of the study farmers were seen practising self-prescription (96%) and self-administration (77%) of ABs on their animals. This is consistent with findings that also reported these practices in LMICs such as Nigeria or Sudan where veterinary services were unavailable and ABs could be purchased over-the-counter (Alhaji & Isola, 2018; Eltayb *et al.*, 2012). In Vietnam, farmers preferred their own experiences to consulting a local veterinarian because they also wanted to cut the extra cost of this service. By contrast with other LMICs, Vietnam has a veterinary system in place from central to local levels, performing veterinary surveillance in quarantine and disease prevention. However, when giving prescriptions, the local veterinarians, who should at least be certificated with intermediate veterinary training, were not equipped with the essential facilities for microbiological diagnosis, even with a minimal limited setting laboratory service. Consequently, their prescriptions were still based on their own empirical treatment which could be a reason why farmers valued their own practical experience over the trained knowledge of local veterinarians, who farmers thought did not have sufficient practical experiences in animal farming. These findings are different to those observed in the European Union (EU) and other HICs where veterinarians' advice played an important role in influencing farmers' practices (Friedman *et al.*, 2007; McDougall *et al.*, 2017). Farmers in EU countries had a strong reliance on veterinarians as their most credible or

trusted source of advice for selecting ABs. Furthermore, veterinarians were regarded as the key factor contributing to the success of AB reduction policies in the Netherlands. Their mission was to provide recommendations for farmers to make fundamental changes in farming management or housing to reduce disease problems and subsequently reduce ABU in animals (van Herten & Meijboom, 2019).

The poor law enforcement for veterinary drug surveillance could also be a reason for the practice of self-prescription and self-administration. Vietnamese law does refer to the important roles of veterinarians in monitoring animal husbandry, and regulations that veterinary drugs, including ABs, must be used according to the instructions of veterinary agencies or the prescription of veterinarians (Ordinances on Veterinary Medicine issued in 1993 and 2004 and a Law on Veterinary Medicine in 2015). However, the law regulating the use of veterinary medicines and ABs in animals is commonly not enforced. ABs are still regularly dispensed without prescription, leading to the requirement of other regulations to monitor this issue such as Circular 12/2020/TT-BNNPTNT, issued on September 2020, in which the Ministry of Agriculture and Rural development regulates the responsibilities of farmers, veterinarians and drug sellers in dispensing drug with prescription. However, the impact of this legislation on stopping over-the-counter ABU in animals still remains unclear. Reviewing efforts to monitor ABU with prescription in the human medicine sector shows that this task is very difficult. Accessing ABs without a prescription was still a major problem in this human medicine sector, despite legislation stating that ABs can only be dispensed with a medical prescription since 2003 (Ministry of Health, Decision number 1847/2003/QĐ-BYT) (Nga et al., 2014). The poor law enforcement of

ABU stewardship has resulted in huge challenges to both national and global efforts to control the current curbing of the indiscriminate use of ABs (FAO, 2016b; OIE, 2016). Although my study results indicated unfavourable conditions for efforts to reduce ABU, there was a favourable factor to stimulate appropriate ABU among smallholder farmers. It is the commitment of the government to ABU stewardship and ABR surveillance. The four-year period between 2016 and 2020 witnessed efforts from policymakers to stop the use of ABs for growth promotion in order to combat ABR. They include gradually eliminating and eventually prohibiting the use of ABs for growth promotion and formulating documents for the restriction and eventual prohibition of ABU for disease prevention in animals. Although it is too early to evaluate the effectiveness of these policies, if successful they would seem to offer opportunities for promoting behavioural change via a series of actions related to incentives, bans, communications and nudges (Tummers, 2019).

Intervention strategies are required to stop unnecessary ABU, especially when Vietnam was identified as a hotspot of ABR due to a significant increase in AB consumption in animal husbandry (Boeckel *et al.*, 2015). However, an important consideration is the outcomes of any interventions for public health's benefits would be likely to impact on farmers' interests (Toebes, 2015). Reviewing the historical milestones marking the role of ABs in food animal production worldwide, literature shows that the application of ABU has made an important contribution to the role of this sector. The use of ABs as feed-additive was even proposed as an integral part of the revolution in animal-production technology (National Research Council Committee to Study the Human Health Effects of Subtherapeutic Antibiotic Use in Animal, 1980). Despite increasing

scientific warnings about the emergence of ABR, ABU in animals was still permitted for different purposes because of its economic benefits between 1950 and 2005 (Kirchhelle, 2018; Prescott, 2017). Thus, the application of ABU in animal husbandry is beneficial for farmers, including smallholder ones. However, literature provides evidence that many smallholders had to end their businesses due to poor profitability after the ban of AB growth promoters in Denmark and Sweden (Kahn, 2016). This suggests that smallholders could be particularly affected by the ban which may be challenging in Vietnam where smallholder farms dominate the livestock sector and provide employment to about 9.5 million rural labourers (GSO, 2018). If efforts to reduce ABU in Vietnam lead to the same results like seen in the EU, a huge number of people and households may be faced with unemployment and loss of income, threatening the livelihood and the sustainable development of rural areas. In addition, the negative impacts on farmers' livelihoods could be more serious when they do not have effective tools for risk management, such as participating in agricultural insurance (see Chapter Two). Therefore, smallholder farmers should not be excluded in efforts to reduce ABU against ABR. They should be engaged and considered as partners to mitigate their own potential harms.

In order to stimulate the participation of smallholders in efforts to reduce ABU, education interventions are needed to increase farmers' awareness and appropriate practices related to ABU. Although increasing knowledge does not directly translate into better practices (Toral & Slater, 2012), it is beneficial to increase knowledge in order to improve skills and allow farmers to fully understand the reasons they need to change and how to make that change (Arlinghaus & Johnston, 2017). This idea implies

that education is a way to engage farmers in the public health concern about ABR, so that they would commit to or at least not be resistant to change. People do not fully understand the reasons for change, they are likely to be unwilling to give up their habits and used various tactics to circumvent the new regulations (L. Willis, 2012). Farmers in the Mekong Delta region were interested in learning farming techniques via different sources because they had traditional habits of applying new technologies into their farming for increasing production efficiency (Dũng, 2011; N. Nguyen & Ohara, 2005). In this study, farmers also showed interest in taking part in local training workshops to learn solutions for farming management, including dealing with animal diseases, therefore suggesting this is a feasible approach to engage farmers.

A bottom-up approach to promote behaviour change among farmers and to engage them in the efforts to reduce ABU could be from the grassroots levels via pioneer farmers. These farmers were motivated by their responsibility and competence to produce the highest quality of animal products. They had experienced with successful solutions and were willing to contribute to the development of the wider livestock and poultry sector by sharing their experiences or ideas with other farmers. They had the ambition to connect other smallholder farmers into networks for enhancing the power and voice of farmers for sustainable development of animal husbandry. Thus, they could play a role as successful models for other farmers within the communities. Bandura's social learning theory proposed that learning could occur by observing the actions of models (Bandura, 1991). Farmers in the Mekong Delta preferred information or experience supplied by neighbours to those provided by outsiders (N. Nguyen & Ohara, 2005). This was because neighbouring farmers as peers shared the common

characteristics, circumstances and experiences, which could promote their acceptability and influence to target farmers. Literature on human immunodeficiency virus (HIV) prevention suggests that peer interventions could be possible because they are based on part on community's availability, accessibility, and low cost in comparison to professional veterinary care providers (Medley *et al.*, 2009). In this study, pioneer farmers appeared in both those owning either small or medium sized farms (see Chapter Seven). Therefore, they could act as models and community activists to influence other farmers having their same sized farms and to motive changes at the grass-root levels. Hesitant and conventional farmers could learn both failures and successes from pioneer farmers, then they could internalize the information and make choices in line with their personal circumstances.

Hesitant farmers should be targeted for intervention in early stages of the intervention programme because they generally want to change, but they do not have favourable conditions for doing so. Unfavourable conditions included a lack of capabilities and opportunities to adopt AB reduction. This lack made them not confident in adopting alternatives to ABs despite their moral conviction (Bandura, 2010; James & Hendrickson, 2008). Providing training on effective guidelines of good farming practices and modelling could be one approach of feasible intervention to promote their capabilities for behavioural change. However, with only increased knowledge and moral conviction to change, these farmers would not have enough motivation to pursue their morality and face economic pressure. Therefore, these farmers also need other external favourable conditions to support their desire to change. There should be an improvement of legislation for restructuring the animal farming environment, planned

development of animal production, guidelines for appropriate practices, and service provision for facilitating their animal farming (Michie *et al.*, 2011).

Among the three farmer groups, conventional farmers should be the main target of a long-term intervention program to promote safe farming practices and the prudent use of ABs. They represent the majority of livestock and poultry farmers in Vietnam, who place much value on ABs and production efficiency and hold a belief that they are using ABs in a "considered manner". This belief implied that these farmers did not share the judgement that they were overusing ABs on farms. Moreover, with the practice of sub-therapeutic ABU, these farmers thought they were doing the best for their animals, resulting in healthy animals, no AB residue remaining in animal products, and subsequently benefiting consumers' health. However, their misunderstanding of the benefits and harms of ABU in food animal production might prevent them from appropriate perceptions and practices. For example, these farmers thought active prevention with low concentration low of ABs resulted in healthy animals, however, they did not recognize that these animals could be really unhealthy with injuries to the liver and kidney; or they might think this problem could be solved with the common use of antitoxin drugs. In human medicine, there is evidence for hepatotoxicity associated with the use of ABs such as Amoxicillin or Flucloxacillin (Robles *et al.*, 2010). In addition, they saw their animals were healthy and had good productivity with sub-therapeutic ABU and guessed that the animals were free from AB residue and therefore, there would be no harms to human health. However, they might not know that low levels of AB exposure would also cause residue in animal waste, contaminating the environment, and resulting in alteration of microflora and

development of resistant strains which could cause infectiveness of AB therapy (Manyi-Loh *et al.*, 2018). Therefore, more comprehensive solutions including improving their awareness and providing favourable external conditions to promote safe farming practices and prudent ABU would be required before this group would be ready to change. In addition, the success of pioneer farmers and hesitant farmers could be utilized as models for motivating conventional farmers to change.

In our on-going studies, a public engagement project will be implemented, in which pioneer farmers will be invited to participate in a Community Advisory Board – CAB. The CAB members include pioneer farmers, local veterinarians and representatives of the Women and Youth Union who fully understand their communities and have different perspectives related to livestock farming. They will discuss and suggest solutions for stimulating other farmers to use ABs appropriately. They will also act as a bridge to connect scientists, local authorities and farming communities in order to create favourable conditions for changes. The CAB members will participate in training for trainers in order to promote their capability related to farming skills, ABU and communication. Then, some local communication activities will be held by the CAB to raise awareness of farmers about ABU and ABR. An expected outcome of this project is an evaluation report about the effectiveness of the CAB as a tool for public engagement.

Here I identify three limitations of this study relating to the methodology and study design. Firstly, this study was designed with a small sample of one hundred farmers to obtain rich in-depth data on farmers' experiences and views. Although this study applied mix-method, I focused more on qualitative information for explanatory.

Therefore, the study results could not be generalized on the larger population scale. Secondly, I did not ask directly farmers about their income. In many sociology studies, income was an indicator to understand economic factor which could influence actors' decisions and practices. The reason was, from my own experience, income was one of the sensitive issues that informants might not feel comfortable to share. Especially to farmers, they did not have a monthly salary. Their income was not steadily and hard to calculate. In another study of mine in 2010, when I investigated farmers' income and expenses and asked farmers detailing relevant information via a checklist. The result was that the monthly expenses were always higher than monthly income. To fix this problem, in this study, I used farming scale replacing for income with an assumption that different farming scale will influence farmers' KAP. However, data analysis also did not show a significant association. Lastly, one result in this study showed that local training events which were organized mainly by vet-drug companies had affected farmers' perception and practices of ABU. However, I had not promptly added observational tools to study more of these events. The reason was I could not access information sources of the training venues to conduct observations for more evaluations. Thus, all information relating to training events were mainly provided by informants and Sub-department of Animal health and husbandry.

9.2 Concluding remarks

This study showed the limitations of farmers' knowledge, attitudes and practices towards ABU and ABR, resulting in the lack of sharing the same concern of public health about ABU and ABR. Although the ABU as a tool for protecting animal health

was driven by farmers' economic motivations, farmers also had non-economic considerations when making decisions. The intention to reduce ABU on farms among pioneer farmers clearly showed non-economic motivations when they considered moral obligations to provide safe animal products for consumers and produce the highest quality of animal products. This could be seen as one of the favourable conditions for engaging farmers in efforts to reduce ABU on farms. While we are waiting for synchronous solutions to enhance appropriate ABU from policymakers, it is necessary to utilized community resources, including the role of pioneer farmers who act as a bridge between external resources and internal community efforts to promote ABU reduction on farms.

Appendix A

Questionnaires

1- Quick survey

1....Name of informant: ……..
2. Gender: O Male O Female
3....Years of birth: ……..
4. Position: □ Farm owner □ Decision maker □ Worker on farm
5....Address: …….
6....Telephone: …….
7. Farm characteristics:
   □ Having pond(s) □ Nearby river □ Others
8. Types of livestock animals and (b)quantity:
   O Chicken (b) ……
   O Pig (b) Sow: …… Finisher: ……Piglet:……
9. When do you want to start a new circle of farming? ……..
10. How many animals will you keep in the next farming circle?
    a. Chicken: …….. b. Pig: …….
11. Via the meeting, have you known well our project?
    O Yes O No
12. Are you aware of your benefits and potential harms if you participate in our project? O Yes O No
13. Would you like to be our project participant?
    O Yes O No
    a. Would you like to participating in our interviews?
       O Yes O No
    b. Would you like to consent for farm/ animal sample collection?
       O Yes O No
    c. Would you like to participating in our art science activities (photographing, filming)
       O Yes O No
14. Do you have any question about our project? O Yes O No

2 - KAP Questionnaire

Part 1 – Animal farming practices

1. ***How long has your household been in the business of animal farming?***
   [__|__] year

2. ***What types of cattle or poultry do you currently farm?***

No	Type of cattle	Quantity	Scale
1		[__|__||__||__|__]	O Family O Business
2		[__|__||__||__|__]	O Family O Business
3		[__|__||__||__|__]	O Family O Business

3. ***How many members are there in your household participating in animal farming activities?*** **[__|__]** person (s)
4. ***How far is it from the housing area to the animal farm?*** **[__|__|__|__]*m***
5. ***What are the farming facilities?***

Facilities	
1. Animal houses	OYes O No
2. Fences	OYes O No
3. Biogas cellar	OYes O No
4. Storehouse containing feed, vet drugs and other farming tools…	OYes O No
5. Farm diary	OYes O No
6. Others	OYes O No

6. ***From which source do you often get animal breeds?***
   a. From other household farms in the locality ☐
   b. From company/ wholesalers ☐
   c. From own farms ☐
   d. Other places _____ ☐

7. ***Which factors influence farmers' choice in buying breed?***
   (Choosing in order of priority from 1-8, list the most preferred)

Factors	***Priority level***
1. Low price	**[__]**
2. Self-experience, that place sells good breeds (Close connection)	**[__]**
3. Clear original source	**[__]**
4. Breeds with vaccination certification	**[__]**
5. Breeds with health certificate	**[__]**
6. Good conformation of livestock	**[__]**

7. Healthy countenance of livestock	[__]
8. Others	[__]

8. ***What are your expectations in animal farming?***

_____

9. ***Which factors do you concern and influence your decision in animal farming?***

a. Factor	**b. Important level**	
1. Production cost	[__]	[__]
2. Farming hygiene	[__]	[__]
3. Fate water and food source	[__]	[__]
4. Animal weight	[__]	[__]
5. Epidemic diseases	[__]	[__]
6. Selling price of finishing animals	[__]	[__]
7. Others	[__]	[__]

10. ***How often do you tidy your farm***? (1- every day, 2 – several times per week, 3 – several times per month, 4 – rarely, 5 – never)

Place/equipment of hygiene practice	**Level**				
	1	2	3	4	5
a. Animal house	○	○	○	○	○
b. Farming tools	○	○	○	○	○
c. Water drainage system	○	○	○	○	○
d. Food storage	○	○	○	○	○
e. Water tank	○	○	○	○	○

11. ***What are the main sources of drinking water and running water for your farm?*** (Maximum 2 choices)

Sources of water	**Drinking water**	**Running water**
a. Deep well water	☐	☐
b. Hollow well-water	☐	☐
c. Rain- water	☐	☐
d. River/lake/ canal water	☐	☐
e. Others	☐	☐

12. ***How do you eliminate waste – water from animal farming?***

a. Waste-water goes out the garden ☐
b. Waste-water goes out biogas cellar ☐
c. Waste –water goes out canal without being processed. ☐
d. Others ☐

13. ***Do you often apply any of the following habits?***

Farming practices	
a. Wash hands with soap before and after interacting with livestock	○Yes ○ No
b. Change clothes when entering holding pens	○Yes ○ No
c. Change shoes when entering holding pens	○Yes ○ No
d. Have special place to isolate suspected or sick livestock	○Yes ○ No
e. Allow livestock go freely outside the holding pens	○Yes ○ No
f. Slaughter livestock at home (to obtain meat)	○Yes ○ No
g. Slaughter suspected sick livestock (to sell or to consume)	○Yes ○ No
h. Sell out suspected sick livestock	○Yes ○ No
i. Cremate/Bury diseased animals at home	○Yes ○ No
j. When livestock get sick, purchase treatment drugs based on self-experience	○Yes ○ No
k. Read carefully manuals before applying drugs for treatments of livestock	○Yes ○ No
l. Ask the pharmacist carefully before applying drugs for treatment of livestock	○Yes ○ No
m. Consult the veterinarians carefully before purchasing drugs for treatments	○Yes ○ No
n. Vaccinate livestock right on schedule	○Yes ○ No
o. Often stop using drugs (with antibiotics) immediately after noticing diseases in livestock	○Yes ○ No

14. When do you often use antibiotics for your animal***? (MA)***

a. When animal gets disease ☐
b. When outbreak of diseases ☐
c. Seasonal change ☐
d. Use often for prevention ☐
e. To promote animals' growth ☐
f. Others ☐

15. ***When epidemic disease happens, what do you often do? (MA)***

a. Immediate vaccination ☐
b. Apply antibiotics to livestock ☐
c. Clean house and farm ☐
d. Isolate livestock ☐
e. Others ☐

16. ***How long after applied antibiotics, are the livestock released?*** **[__|__|__] days**

17. ***Do you use meat from your animal husbandry?***

○ Yes (next to question 18) ○ No (Next to question 20)

18. ***If yes, rate your frequency?*** ○Very often ○ Often ○ Occasionally

19. ***How do you feel when using meat from your animal husbandry?(MA)***

a. Feel safer (hygiene issue) ☐
b. Fell higher quality ☐
c. Having more economic benefits (cheaper than purchasing commercial products) ☐
d. Others ☐

20. ***If you do not frequently consume such meat, what are the reasons? (MA)***

a. Be afraid that your livestock's meat was infected by diseases ☐
b. Be afraid that your livestock's meat has antibiotics ☐
c. Be afraid that your livestock's meat was unclear due to slaughter process ☐
d. Other ☐

21. ***Where do you find help or advice if facing any difficult situations in animal farming during the past two years?***

a. Individuals, Organizations, Unions	a. ***Within 2 years***	
	1.Choose	***2.Time (s)***
a. Local veterinarians	☐	
b. Hamlet Farmers Association	☐	
c. Veterinary medicine store	☐	
d. Livestock feed store	☐	

e. Neighbors or friends with animal farming experience ☐

f. Self-study, research via magazines, books, Internet ☐

g. Other individuals/organization:…… ☐

22. ***Last year, how many times did you participate in training events related to livestock farming***? [__] *times /year*

23. ***If yes, who did organize such training courses***? ***(a)? Content(b)***

(a)_____

(b)_____

24. ***Your level of agreement to the following evaluations: (***1. Strongly agree; 2. Agree; 3. Both agree and disagree; 4. Disagree; 5. Strongly disagree; 99. No idea/ Difficult to answer)

Evaluations	*Level of agreement*					
	1	2	3	4	5	99
a. In animal farming, the use of antibiotics is very necessary	○	○	○	○	○	○
b. The antibiotics I am using do not possess any harm to consumers	○	○	○	○	○	○
c. I have low risk in contracting zoonotic diseases	○	○	○	○	○	○
d. It is difficult to change the current animal farming practices	○	○	○	○	○	○

II – **Safe Animal Farming Knowledge**

A. Safe animal husbandry

25. ***In your opinion, what is safe animal farming?***

26..*In your opinion, what is the purpose of safe animal farming*?(1-totally unimportant; 5- totally important)

	Level of importance				
	1	2	3	4	5
a. To improve profit due to higher productivity	○	○	○	○	○
b. To prevent disease outbreaks	○	○	○	○	○
c. To improve quality and safety of products	○	○	○	○	○
d. To improve animal welfare	○	○	○	○	○
e. To satisfy consumers	○	○	○	○	○

f.	To fulfill demands of ensuring consumers' health	○	○	○	○	○
g.	To protect farmers' health	○	○	○	○	○
h.	To avoid penalties	○	○	○	○	○
i.	To fulfill conditions of being licensed for farming practices	○	○	○	○	○
j.	Others	○	○	○	○	○

B. Zoonoses

27..*In your opinions, what are the sources of diseases to livestock?*

28..***Which sources that can infect diseases for livestock***?

Sources

a....Non-isolated animals with infections	○ Yes ○ No
b....Rodent or insect carriers	○ Yes ○ No
c....Contaminated water	○ Yes ○ No
d....Contaminated air	○ Yes ○ No
e....Contaminated foods	○ Yes ○ No
f.... Unhygienic holding pens	○ Yes ○ No
g....Unhygienic farming equipment	○ Yes ○ No
h....Pathogens come from farmers	○ Yes ○ No
i.....No idea	○ Yes ○ No

29..*Do you know about zoonotic diseases?*

○ Completely unaware (To question 32)

○Aware of some diseases (To question 30)

30..*If you have knowledge about some zoonotic diseases, what are they?*

31..***From the given list, which are zoonotic diseases?***

a. *Streptococcus suis* serotype 2 infection	○ Correct	○ Incorrect	○ Don't know
b. H5N1	○ Correct	○ Incorrect	○ Don't know
c. Porcine reproductive and respiratory	○ Correct	○ Incorrect	○ Don't know

syndrome (PRRS)

d. Anthrax	○ Correct	○ Incorrect	○ Don't know
e. Newcastle disease	○ Correct	○ Incorrect	○ Don't know
f. Leptospira	○ Correct	○ Incorrect	○ Don't know
g. Foot and mouth disease (FMD)	○ Correct	○ Incorrect	○ Don't know
h. H1N1	○ Correct	○ Incorrect	○ Don't know
i. Taeniasis	○ Correct	○ Incorrect	○ Don't know

32.*.How do you think you and your family have the risks to contract zoonotic diseases?*

○Very high risks (to question 33)

○Not worrying risks (to question 33)

○Completely no risks (to question 34)

○No idea/ Difficult to answer (to question 34)

33.*.Reasons for such evaluations?*

a. Frequent contact to infected livestock ☐
b. Frequent contact to animal waste ☐
c. Eating meat from infected livestock ☐
d. Others ☐

34.*.What are your measures to prevent transmission of zoonotic diseases?*

35.*.Which of measures provided below can prevent transmission of zoonotic diseases?(MA)*

a. Be proactive in vaccination for farmed animals
b. Take hygiene of farms according to veterinary physicians' instructions
c. Isolate animals with suspected diseases
d. Do not consume animal products with suspected diseases
e. Burning or burying sick animals following instructions
f. from veterinary physicians
g. Use labour safety in contacting with livestock
h. Freshen up your body frequently
i. No idea

C. AMU

36. ***In your opinions, what are antibiotics?***

37. ***In your opinion, what are the reasons of antibiotic usage?***

a. To promote animals' growth ☐
b. To prevent disease for animals during outbreaks ☐
c. To treat sick animals ☐
d. Others (Please specify): ☐

38. ***In your opinions, what effects does the overuse of antibiotics in animal farming bring to livestock, farmers and the health of consumers?*** (1. Completely no effects; 2. Little, uncountable effects; 3. Great effects; 99. No idea/ Difficult to answer) – (Put code of choice in column 1)

Target	**1. Level of effects**	**2. State of effects**
a. Pigs/Chickens	[___]	_____
		_____
b. Farmers involved in animal husbandry	[___]	_____
		_____
c. Consumers of animal farming products	[___]	_____
		_____

39. ***Do you have any idea about the problems of antibiotic-resistance?***

○ Completely have no idea (To question 42)

○Have heard of but have no understanding (To question 42)

○Little understanding (to question 40)

○Clear understanding about the problems of antibiotic-resistance (to question 40)

○Others ……

40. ***If you do, in your opinion, what is antibiotic-resistance?***

41. ***Reasons for antibiotic resistance?***

a. Wrong dose in applying antibiotics (higher or lower) ☐
b. Wrong use in applying antibiotics ☐
c. Prolong/Short-time use of antibiotics ☐
d. Others (Please specify): ☐
e. No idea/ Difficult to answer ☐

42. ***Have you ever heard about any solutions for reducing antibiotic uses?***

○Have heard and understand (*to question 43*)

○Have heard but not understand much (to question 49)

○Never (to question 49)

43. ***If have heard about any solutions, what are they? what are their purposes?***

(a)_____

(b)_____

44. ***Have you ever thought that you would adopt the solutions for reducing antibiotics?***

○Yes (to question 47) ○ Never (to question 48)

45. ***In this list, which are the solutions for reducing using antibiotic?***

Contents	
Supplement organic acids into foods	○ Correct ○ Incorrect ○ Don't know
a. Supplement enzymes	○ Correct ○ Incorrect ○ Don't know
b.... Supplement probiotics and prebiotics	○ Correct ○ Incorrect ○ Don't know
c.... Supplement foods rich in minerals content	○ Correct ○ Incorrect ○ Don't know
d.... Use herbal antibiotics	○ Correct ○ Incorrect ○ Don't know

46. ***Do you have experienced about using alternatives to antibiotics?***

○ Yes ○ Never

47. ***If already experienced, can you please share the effectives of applying such measures to reduce using antibiotic?(MA)***

a. Reduce production cost ☐
b. Healthy animals, better growth ☐
c. Selling animals at a better price ☐
d. Effect but insignificant ☐
e. Totally ineffective ☐
f. Don't know how are the effects of such measures ☐
g. Others ☐

48. ***Are you willing to use alternatives to antibiotics use in animal farming?***

○Very willing

○Reluctant over the high price of alternative measures

○Not sure how to apply alternative measures

○Not sure about the effectiveness of alternative measures

○Reluctant over the effects to farming productivity

○Others

49. ***How do you get information about safe farming? (MA)***

a. Self-experiments and applications ☐
b. From newspaper, television (Public media) ☐
c. From animal farming training sessions ☐
d. From local media (leaflets, posters) ☐
e. From exchanging information with friends, neighbors ☐
f. Others ☐

III – Attitude

A...Safe animal husbandry

50. ***How do you evaluate the level of safety at your household farm?***

○Very safe ○Unsafe

○Safe ○Very unsafe

○Quite safe

51. ***Reasons for such evaluations?***

_____

52. ***Please share the current productivity level in animal husbandry?***

○ Very productive ○ Not productive

○ Productive ○ Completely not productive

○ Quite productive

53. ***Reasons for such evaluations?***

54. ***Do you feel assured using products of animal farming in your local area?***

○ Very assured ○ Unsure

○ Assured ○ Completely unsure

○ Quite assured ○ No idea/ Difficult to answer

55. ***Reasons for such evaluations?***

B...AMU

56. ***In your opinions, how is the current need for using antibiotics in animal farming?***

- ○ Very necessary
- ○ Necessary
- ○ Not necessary
- ○ Completely not necessary
- ○No idea/ Difficult to answer

57. ***Reasons for such evaluations?***

58. ***In your opinions, how popular is the use of antibiotics for animal farming?***

- ○ Very unpopular
- ○ Not popular
- ○ Popular
- ○ Very popular
- ○ No idea/ Difficult to answer

59. ***Reasons for such evaluations?***

60. ***What are the obstacles for taking measures in safe farming?***(1- Totally not important; 5 – very important)

Obstacles	1	2	3	4	5
1. Too expensive	○	○	○	○	○
2. Too much administration	○	○	○	○	○
3. Too much work	○	○	○	○	○
4. Do not believe that this would be beneficial	○	○	○	○	○
5. Do not believe that it would help to prevent animal diseases	○	○	○	○	○
6. Not confident as refusing to use antimicrobial for animal	○	○	○	○	○
7. I' m not willing to	○	○	○	○	○
8. It is unnecessary to apply safe farming due to too small size of farming	○	○	○	○	○
9. Not mandatory	○	○	○	○	○
10. Others	○	○	○	○	○

61. ***To what extent these individuals, organizations, and unions in supporting better animal farming for farmers?*** (1. Very necessary; 2. Necessary; 3. May be unsure about necessary; 4. Unnecessary; 5. Very unnecessary)

Individuals, Organizations, Unions	1	2	3	4	5
1. Local veterinarians	○	○	○	○	○

2.	Hamlet Farmers Association	○	○	○	○	○
3.	Veterinary medicine store	○	○	○	○	○
4.	Livestock feed store	○	○	○	○	○
5.	Neighbours or friends with animal farming experience	○	○	○	○	○
6.	Other individuals/organizations:	○	○	○	○	○

62. ***For a safe and productive animal farming, what kind of supports do the farmers need?(MA)***

a. Guides for places to get good breeds
b. Guides for safe animal farming procedure
c. Guides for information to obtain feeds for livestock with good quality
d. Timely instructions for medicine usage in livestock prevention and
e. treatments of diseases
f. In time information provided and updates on cattle and poultry
g. disease outbreaks
h. Guides for antibiotic alternatives usage
i. Information regarding harmful effects of antibiotic overuse
j. Other

63. ***Please grade your satisfaction level with local veterinarians***

Abilities and Qualification	**Grade**
1. Technical knowledge	/ 10
2. Abilities to convey knowledge to the people	/ 10
3. Abilities to convey production techniques to the people	/ 10

64. ***Frequency that local or regional veterinarian inspectors come to your household to inspect and evaluate the activities of animal farming?*** ….. Times / year

65. ***If there is a training course of safe animal farming, do you willing to participate?***

○ Yes ○ No ○ Don't know

66. ***If yes, how many days for such training course?*** ……. Day(s)

67. ***What contents do you expect to learn from such a training course?***

68. Which suitable months to organize such training course?

Part IV – General information about respondent and household:

69. ***Gender***: ○ Male ○Female

70. ***Year of birth:*** [__|__|__|__]

71. ***Ethnicity***: ○Kinh ○ Hoa ○Khmer ○Others _____

72. ***Education*** (Please specify)

○ Not know how to read and write/ know how to read and write

○ Primary school

○ Secondary school

○ High school

○ Post-secondary education (higher education)

○ Tertiary education (College or University)

○ Graduated degree

73. ***Who is responsible for the livestock?*** (take care of, feed, monitor diseases,….) (record in relation to the respondents)

○ Respondent

○ Respondent's husband/wife

○Respondent's children

○ Other (Please specify): .....

74. ***How many years in accumulated experiences does the person responsible for livestock in the household have***? [__|__] years

75. ***How many years in accumulated experiences does the interviewee have for livestock in the household?*** [__|__] years

3 - Additional questionnaire 2017

1. **How many types of feed do you use on farms?**
   ……
2. **Does feed you are using on farms contain antibiotics?**
   Yes No Don't know

   If yes, please list name of antibiotics:……
3. **Do you often change feed brand name? and Why?**
4.
5. **How do you often read information printed in feed label?**
   ○ Very often ○ Sometime ○ Never
6. **Which information printed in feed label do you concern? (MA)**
   ☐ Nutritional ingredients ☐ Expiry date

   ☐ Contents ☐ Other …

   ☐ The presence of antibiotics

7. **Which criteria do you base to choose commercial feed?**
8. **What is your level of concern about the presence of antibiotics in feed?**
   ○Extremely concerned Somewhat concerned ○Not at all concerned
9. **The reasons for your attention or not attention to the presence of antibiotics in feed?**
10. **Do you know in the near future, feed producers will not mix antibiotics into feed?** Yes No
11. **How do you think if feed producers will stop add antibiotics into feed?**
12. **Do you add antibiotics into feed?** Yes No
13. **The reasons for adding (or non-adding)?**

4 - Guideline for in-depth interview to farmers

A- **Farming goals: Why are you working in the livestock farming?**

1. When did you begin raising livestock animals? Why? (*why did you keep livestock animals, which types of animals? how was your work?*)

2. What are your expectations in livestock farming?

3. Are there any differences in raising animals between now and the past? Do you know how and why? (*prompt: focusing on changes, favourable and unfavourable conditions*)

B- Beliefs: How do you think about livestock farming and ABU?

4. What are the advantages in your farming? How have you exploited such advantages?

5. What are your most worries in keeping animals?
Prompt: among such worries, which is the most? and why? What are the differences towards the worries between now and past? What are the potential harms (human diseases, animal diseases, economic loss…) ? Who or what could be affected by these harms? (human health issue, animal health and productivity)

6. How do you cope with your worries in keeping animals? And why do you do that? (*Prompt: focusing on both internal and external sources that farmers use to cope with their worries, what did they do in the past, now, and their intention?*)

7. How do you think about antibiotic use and reduction on livestock farm? (Should we reduce AB on farms? *Why do you support/ not support for an idea of reducing AB on farm? What are the benefits or harms do you perceive? What are your solutions? Are you confident in applying antibiotic reduction)*

C- Self-efficacy: How are you confident in your decision making in animal production?

8. Within livestock farming works, what could be your most/ least confidences in decision making? *(Prompt: among the tasks you make your own decisions, what could be your most or least confidences? If you are not confidence with your decisions, what do you do at that time? Who do you ask for advice? (Want to know which supportive sources farmers use: peers, vets, drug sellers, scientists?....)*

9. Among the measures that you implement to prevent animal diseases, which do you think are most efficacious? How's about the others? And why? How do you comply now and future?

10. (if you want to reduce ABU), among the alternatives to antibiotics, which do you think are most efficacious? How's about the others? And how is your intention?

11. According to you, what are good farming practices (*Prompt: what are good farming practices? Specify which actions of good framing practices? What are your motivations or reasons? Focusing much on measures to control diseases and reduce ABU?*)

D- Farmers' consideration: Who or what could be your consideration in daily farming decisions, practices and using AB?

12. Who or what could be your consideration in making decisions on farms, including ABU? (economic benefits? Animal welfare? Your own health, consumers' safety…)

13. Which could be your most important considerations in your decision making in animal production?

14. Please tell us any situations make you consideration during decision making? Why

Is there anything else you would like to add? - Thank you for your time

Appendix B

Additional table results

Chapter 2 – A summary of relevant regulations

General agricultural policies

Year	Legal Documents	Main contents
2000	Resolution 09/2000/NQ-CP, dated June 15, 2000	• Resolution on a number of Undertakings and Policies on Economic Restructuring and Consumption of Farm Produce • Provides broad policy framework for the development of a number of agricultural sectors. Key policy directions for animal husbandry are: Pigs -efforts should be concentrated on developing the pig herd suitable for domestic consumption demand. In key areas with suitable conditions, pig raising for export should be promoted. Cattle - high productivity Zebu type beef cattle should be developed to meet demand for beef and hides. Dairy cattle development should be highly promoted in mountainous and mid-land areas. Poultry - poultry should be developed to meet increasing domestic demand, also promote the development of high quality poultry for exports.
2000	Directive 22/2000/CT-TTg, dated October 27, 2000	• On the Strategy of Developing the Export and Import of Commodities and Services in the 2001-2010 period: providing strategy for export development including high quality livestock products
2001	Decision 02/2001/QD-TTg, dated January 2, 2001	• Decision on Policies of Investment Support From the Development Assistance Fund for Exports Production and processing Projects and Agricultural Production Projects • Entitles projects on export production and processing and agricultural production projects to borrow investment capital up to 90 percent of investment value from the Development Assistance Fund. The Development Assistance Fund will provide guaranty for 100 percent of loans for such projects if funds are borrowed from other credit institutions.

2001	Circular 62/2001/TT-BNN, dated 5 June 2001	• Guiding the Export and Import of Goods Subject to the Specialized Management by the Agriculture Service under the Prime Minister's Decision 46/2001/QD-TTg of April 4. 2001 on the Management of Goods Export and Import in the 2001-2005 Period. • This circular defines management systems for the export and import of agricultural products including breeding livestock. Includes customs procedures and permits required for import and export.
2001	Decision 65/2001/QD-BTC ,dated June 29, 2001	• Decision on Rewards Based on Export Turnover of Rice, Coffee, Pork and Canned Vegetables and Fruits in 2001. • Announces export reward levels for a number of commodities. Level of support for suckling pigs is set at D280 per $US1 of export value for suckling pigs and D900 per $US1 of export value for pork pieces.
2001	Decision 166/2001/QD-TTg, dated Oct 26, 2001	• Decision on a Number of Measures and Policies to Develop Pig Farming for Export in the 2001-2010 • This decision encourages the development of zones for export of high quality pigs.
2008	Decision no 10/2008 / QĐ-TOT on Jan 16, 2008	Prime Minister approving the strategy on animal breeding development up to 2020;
2008	Decision no. 1504/QD-BNN-KHCN MARD, dated May 15, 2018	Decision for encouraging poultry producers applying Husbandry Practices to prevent risks from diseases and infection and to protect poultry product’s safety and quality as well as human
2008	Decision no. 1506/QĐ-BNN-KHCN MARD	Promulgating good animal husbandry practices for safe pig production.
2008	Decision No. 121/2008/QĐ-BNN on Dec 17, 2008	Promulgating "Regulations on certification of implementing good animal husbandry practices (VIETGAHP) for dairy cow, pig, poultry, and bee farms"
2011	Decision No. 1947/QĐ-BNN-CN on Aug 23, 2011	Promulgate good animal husbandry practices for safe pig farming in households
2011	Decision No. 1948/QĐ-BNN-CN on Aug 23, 2011	Promulgate good animal husbandry practices for safe chicken farming in households
2012	Decision No. 124/QĐ-TTg on Feb 02, 2012	Approving the master plan on agricultural production development up to 2020 and a vision to 2030 (land, raw material areas for animal and animal feed production)
2012	Circular No. 48/2012/TT-BNNPTNT on Sept 26, 2012	Regulations on certification of aquatic products, cultivation, and husbandry products produced and preliminarily processed in accordance with good agricultural production practices.

2012	Decision No. 2970/QĐ-BNN-CN on Jan 23, 2012	Regarding the certification of livestock products produced according to good animal husbandry practice procedures for pig and chicken farming in households of LIFESAP project areas in a number of central provinces and cities.
2014	Decision No. 984/QĐ-BNN-CN on May 9 2014	Approving the project "Restructuring the husbandry industry towards value-added increase and sustainable development"
2014	Decision No. 985/QĐ-BNN-CN on May 9 2014	Promulgating action plan to implement the project "Restructuring the husbandry industry towards value-added increase and sustainable development"
2015	Decision No. 4653/QĐ-BNN-CN on Nov 10, 2015	Promulgating procedures of good animal husbandry practices (VietGAHP)
2016	Decision No. 2509/QĐ-BNN-CN on Jun 22, 2016	Promulgating regulations for certification and good animal husbandry practices of safe pig and chicken farming in households.
2016	Decree No. 66/2016/NĐ-CP on July 01, 2016	Regulations for business investment conditions on plant protection and quarantine; type of tree; ordinary forest animal farming; animal husbandry; seafood; food.
2018	Decree No. 57/2018/NĐ-CP on April 17, 2018	Mechanisms and policies to encourage enterprises to invest in agriculture and rural areas.
2018	Law on animal husbandry No. 32/2018/QH14 on Nov 19, 2018	Clause b, Section 2, Article 4 of the Law stipulates: Building animal husbandry areas free from epidemics and biosecurity; treating livestock environment; developing models of good animal husbandry practices; relocating livestock farms out of cities, towns, townships or residential areas not allowed to raise animals; Article 12 of the Law stipulates: Breeding behaviour in areas not allowed to raise animals of cities, towns, towns and residential areas; except for raising companion animals, raising animals in the laboratory without polluting the environment.
2018	Circular No. 37/2018/TT-BNNPTNT on Dec 25, 2018	Promulgating the list of national key agricultural products.
2018	Decree No. 58/2018/ND-CP, dated April 18, 2018	Decree of the Government on agricultural insurance - Specifically, there are 3 objects are supported for agricultural insurance, include: crops, livestock and aquatic animals Insured risks eligible for support including: Natural disaster risks; Animal epidemics and plant pests.

Environmental regulations

Year	Legal Documents	Main contents
2005	Environmental Law No. 52/2005/QH11, dated Nov 29, 2005.	Provides clear obligations and responsibilities of organizations, households, and individuals for environmental protection. Article 14: Objects that are subject to strategic environment assessment reporting. Article 18: Objects that are subject to preparation of environmental impact assessment reports. Article 19: Preparation of environmental impact assessment reports. Article 20: Contents of environmental impact assessment reports. Article 24: Objects that are subject to environmental protection commitments. Article 25: Contents of environmental protection commitments. Article 26: Registration of environmental protection commitments.
2005	Decision No. 3065/QD-BNN-NN, dated Nov 7, 2005	Provides regulations on bio-security-related conditions of the areas to operate production, hatchery, transportation, slaughtering, and marketing of poultry and poultry products.
2006	Decree No. 80/2006/ND-CP by the Prime Minister, dated August 9, 2006	Provides details on and guides the implementation of a number of articles of the Law on Environmental Protection. Addresses activities related to agriculture, including EIA, waste management, and rural environmental protection.
2007	Decree no. 59/2007/NĐ-CP, dated April 09, 2007	Provides regulations on management of solid waste and the rights and obligations of entities related to solid waste.
2007	Circular No. 07/2007/TT-BTNMT of MONRE dated July 3, 2007	Guides the classification of polluting establishments to be addressed and guides decision making regarding this list of polluting establishments. Agricultural production establishments causing environmental pollution are subjects of the circular.
2008	Decision 1504/QD-BNN-KHCN; dated May 15, 2008	MARD promulgated the Good Animal Husbandry Practices for Poultry, which encourages poultry producers, regardless of scale, to apply good practices to prevent risks from diseases and infection and to protect poultry product's safety and quality as well as human health and environment.
2008	Decree No. 21/2008/ND-CP, by the Prime Minister, dated February 28, 2008	Modifies certain articles of the Decree No. 80/2006/ND-CP dated August 9, 2006. According to these legal documents, large-scale livestock farms with more than 1,000 animals and 20,000 poultry have to carry out an EIA before building to contribute to reducing environmental pollution from livestock operations. Small-scale, smallholder farms have to submit an Environment Protection Commitment Letter, a simple form of an EIA report. The Environment Protection Commitment Letter is registered and the District People's Committee or Commune People's Committee is authorized to provide this kind of 'certificate'.

2008	Decree No. 79/2008/NĐ-CP, dated 18 July 2008	Provides regulation management system, inspection, and testing of food safety. Article 8, Section 2: Inspection contents of food safety in agriculture and rural development.
2011	Circular No. 47/2011/TT-BTNMT dated December 28, 2011	The technical standards for animal wastewater are related to Vietnam's technical standards for industrial wastewater (formerly QCVN 24/2009/BTNMT and later QCVN 40/2011/BTNMT). According to these standards, BOD5 and COD wastewater should maintain at 30 mg/l and 75 mg/l, respectively (very low compared to industrialized countries and Thailand). This discourages livestock farms to adopt treatment systems...
2010	Circular 04/2010/TT-BNNPTNT, dated Jan 15, 2010	MARD issued the Vietnam National Technical Regulation Conditions for Biosecurity of Pig and Poultry farms
2011	Circular 27/2011/TT-BNNPTNT, dated April 13, 2011	Chapter 2 contains provisions on conditions of waste disposal, ensuring environmental sanitation in livestock farms.
2013	Decree 179/2013/NĐ-CP, dated November 14, 2013	Provides regulations on administrative sanctions in the field of environmental protection.
2013	Decree No. 25/2013/NĐ-CP, dated March 29, 2013	Provides regulations on environmental protection charges for wastewater.
2014	Decision 985 / QD-BNN-CN; dated May 09, 2014	Revises and promulgates state management documents on livestock breeds and animal feeds, livestock environment associated with climate change. Promulgates regulations and criteria on livestock breeds, animal feeds, and livestock environments, as well as on disease prevention and veterinary hygiene.
2014	The Law on Environmental Protection 55/2014/QH13, date June 23, 2014	Dated June 23, 2014. Article 69. Concentrated livestock zones must have a plan for environmental protection and meet the following requirements: a. Ensure environmental sanitation for residential areas. b. Ensure collection and treatment of wastewater and solid waste; provide regulations on waste management. c. Cages and farms to be cleaned periodically; ensure prevention and response to epidemics. d. Bodies of animals that died from disease should be managed according to the regulations on hazardous waste management and hygiene and disease prevention.

2014	Circular No. 50/2014/TT-BNNPTNT dated December 24, 2014	Amends the Circular No. 66/2011/TT - BNNPTNT detailing Decree No. 08/2010/ND-CP on the management of animal feeds. Revises and promulgates state management documents on livestock breeds and animal feeds, and livestock environments associated with climate change. Promulgates regulations and criteria on livestock breeds, animal feeds and livestock environments, as well as on disease prevention and veterinary hygiene.
2015	Decree 18/2015/NĐ-CP, dated 14 February 2015.	Provides regulations on environmental protection planning, strategic environmental assessment, EIA, and environmental protection plan.
2015	Decree 19/2015/NĐ-CP, dated 14 February 2015.	Provides detailed regulations on the implementation of some articles of the Law on Environmental Protection.
2015	Decree 38/2015/NĐ-CP, dated 24 April 2015	Provides regulation on the management of waste and scraps, including hazardous waste, domestic waste, general industrial solid and liquid waste, wastewater, industrial emissions, and special waste, and environmental protection in scrap imports.
2015	Circular No. 23/2015/TT-BNNPTNT, dated 22 June 2015	Provides regulations on management of products used in improving the environment in livestock and aquaculture production.
2015	Decision No. 3194 / QD-BNN-CN dated August 11, 2015	Adds biological products including biological padding to the list of products that can be used to improve the breeding environment.
2017	Circular 20/2017/TT-BNNPTNT	Circular 20/2017/TT-BNNPTNT providing guidelines 39/2017/ND-CP on management of feeds
2015	Circular no. 27/2015/TT-BTNMT	Regulation on environmental protection plan to livestock farms having area less than 1,000 m2
2017	Decision No. 397 / QD-CN-MTCN dated April 4, 2017	Regulation on environmental protection measures that includes measures on animal waste treatment; solid waste treatment; wastewater treatment; biogas waste treatment; and on noise from livestock farms.
2018	Law on animal husbandry, No. 32/2018/QH14, dated Nov 19, 2018	Clause b, Section 2, Article 4 of the Law stipulates: Building animal husbandry areas with epidemic safety and biosecurity; treating farm wastes; developing good animal husbandry practices; relocating livestock farms out of cities, towns, townships or residential areas prohibited from animal farming; Article 12 of the Law stipulates (prohibited activities in animal husbandry): Farming activities in restricted areas of cities, towns, townships and residential areas; except for raising companion animals and laboratory animals without polluting the environment.

Regulations on ABU as feed additives and medicines

Year	Legal Documents	Main contents
1993	Ordinance on Veterinary No. 7-L/CTN, dated Feb 15, 1993	Article 40: Any use of veterinary drugs for preventing or treating animal diseases must be based on the instructions of veterinary authority or the prescription of veterinarians or veterinary technicians who have license for practising veterinary medicine. Organizations and individuals who have license for practising veterinary medicine must comply the state's regulation in prescribing medicines for treatments and prevention of animal diseases and other veterinary activities.
1996	Decree 15-CP, dated 19 March 1996, on the Management of Animal Feeds	This decree provides that the state will exert unified management over the production, business, export and import of animal feeds, in order to protect the interests of producers, business people and the end users of animal feeds. It provides for State investment in the animal feed production system and provides for the adoption of appropriate credit policies for the sector. It provides a list of requirements that the businesses must fulfil in order to undertake feed processing. It provides for specific labelling of ingredients of feedstuffs.
1996	Circular 08/NN-KNKL/TT, dated Sep 17, 1996	This guides the implementation of Decree 15-CP (19 March 1996) as it applies to standards for animal feeds.
2001	Decision 166/2001/QD-TTg (26 October 2001) On a Number of Measures and Policies to Develop Pig Farming for Export in the 2001-2010 Period.	This decision encourages the development of zones for export of high quality pigs. It provides that the Ministry of Agriculture and Rural development will coordinate with other government levels and concerned Ministries and branches in appraising the situation of animal feed production in Viet Nam and develop proposals for expanding
1999	Decision No. 46/1999/QDD-BNN/TY on March, 05, 1999	Promulgating regulations on veterinary conditions for producing and trading facilities of veterinary drugs.
2000	Decision No. 35/2000/QĐ-BNN-KNKL on April 05, 2000	Promulgating the list of animal feeds, raw materials for producing animal feeds permitted to be imported and exported in Vietnam in 2000.
2001	Decision No. 45/2001/QĐ-BNN-TY on April 18, 2001	List of veterinary drugs permitted to be produced, exported, imported, circulated, and utilized in Vietnam in 2001.

2001	Direction No. 07/2001/CT-BTS on Sep 24, 2001	Banning chloramphenicol and enhancing management the usage of chemicals, veterinary drugs in aquaculture production.
2001	Decision No. 96/2001/QĐ-BNN on Sep, 2001	Promulgating the list of animal feeds compulsory to announce quality standards.
2001	Decision No. 98/2001/QĐ-BNN on Oct 04, 2001	Promulgating decisions of announcement the list of veterinary drugs permitted to be produced, exported, imported, circulated, and utilized in Vietnam in 2001.
2001	Decision No. 104/2001/QĐ-BNN on Oct 31, 2001	Promulgating temporarily technical decisions for animal feeds.
2001	Decision No. 55/2001/QĐ-BNN/KNKL on May 11, 2001	Announcing of the list of animal feeds, raw materials for producing animal feeds permitted to be imported in Vietnam between 2001 - 2005.
2002	Decision No. 01/2002/QĐ-BTS on Jan, 22, 2002	Banning using a number of chemicals, antimicrobials in aquaculture production and commerce.
2002	Decision No. 40/2002/QĐ-BNN on May 27, 2002	The list of veterinary drugs permitted to product, export, import, circulate, and utilize and eliminate in Vietnam in 2002.
2002	Decision No. 53/2002/QĐ-BNN on Jun 20, 2002	Banning producing, exporting, circulating, and utilizing a number of antimicrobials in animal feed production and commerce.
2002	Decision No. 80/2002/QĐ-BNN on Sep, 06, 2002	Announcing the list of animal feeds, raw materials for producing animal feeds imported in Vietnam between 2002 - 2005.
2003	Decision No. 60/2003/QĐ-BNN on May 06, 2003	The list of veterinary drugs permitted to product, export, import, circulate, and utilize and restrict in Vietnam in 2003.
2004	Decision No. 17/2004/QĐ-BNN on May 14, 2004	The list of veterinary drugs permitted to product, export, package, import, circulate, utilize, and restrict in Vietnam.
2004	Official Dispatch No. 721/CV-NN-TĂCN on Jun 15, 2004	The quality of raw materials of imported animal feeds.
2004	Official Dispatch No. 954/CV-NN-TĂCN on August, 02, 2004	The quality of raw materials of imported animal feeds.
2004	Decision No. 41/2004/QĐ-BNN on August 30, 2004	Announcing the list of animal feeds, ingredients of producing animal feeds imported in Vietnam between 2004 - 2005.
2004	Official Dispatch No. 1388/CV-NN-TĂCN on Oct 29, 2004	The quality of raw materials of imported animal feeds.
2004	Ordinance on Veterinary No. 18/2004/PL-UBTVQH11, dated April 29, 2004	Article 3, clause 4: Veterinary activities mean the work of State management over veterinary medicine and activities of animal disease prevention and treatment, animal-epidemic

		combat; quarantine of animals and animal products; animal-slaughtering control; veterinary hygiene inspection; management of veterinary drugs, veterinary-use bio-products, microorganism, chemicals; veterinary practice. **Article 11, clause 2:** Organizations and individuals, when using veterinary drugs, bio-products, microorganisms, chemicals to prevent, treat diseases for animals, have the responsibility: a) To use veterinary drugs, bio-products, microorganisms, chemicals on the list of veterinary drugs permitted for circulation in Vietnam, the list of veterinary-use bio-products, microorganisms and chemicals permitted for circulation in Vietnam; b) To comply with the use instructions or direction of veterinary doctors or technicians of the veterinary offices, or persons permitted for veterinary practice.
2005	Decision No. 07/2005/QĐ-BTS on Feb 24, 2005	Announcing the list of illegal and restricted chemicals and antimicrobials in aquaculture production and commerce.
2005	Decision No. 25/2005/QĐ-BNN on May 18, 2005	The list of legal, illegal and restricted veterinary drugs in Vietnam
2005	Decision No. 26/2005/QĐ-BNN on May 18, 2005	Announcing the list of vaccines, probiotics, microbiology, and chemicals Supplementing the list of Fluoroquinolone antibiotics prohibited from aquaculture production and commerce exporting in America and North America market.
2005	Decision No. 33/2005/QĐ-BNN on June 09, 2005	Announcing the list of veterinary drugs, raw materials for producing veterinary drugs permitted to circulate until 31 Dec, 2005.
2006	Decision No. 01/2006/QĐ-BNN on Jan 06, 2006	The list of animal feeds and animal feed ingredients permitted to import in Vietnam.
2006	Decision No. 03/2006/QĐ-BNN on Jan 12, 2006	The list of legal, illegal and restricted veterinary drugs in Vietnam
2006	Decision No. 04/2006/QĐ-BNN on Jan 12, 2006	The list of legal vaccines, probiotics, microbiology, and chemicals used in veterinary in Vietnam.
2006	Direction No. 66/2006/CT-BNN on August 25, 2006	Strengthening the management, enhancing the quality of agricultural and forestry products and agricultural materials, and guaranteeing food hygiene and safety.
2006	Decision No. 90/2006/QĐ-BNN on Oct 02, 2006	The list of animal feeds and animal feed ingredients permitted to import in Vietnam.
2007	Decision No. 11/2007/QĐ-BNN on Feb 06, 2007	Announcing the list of legal vaccines, bio-products, microbiology, and chemicals used in veterinary in Vietnam.
2007	Decision No. 12/2007/QĐ-BNN on Feb 06, 2007	Announcing the list of legal, illegal and restricted veterinary drugs.

2007	Decision No. 767/2007/QĐ-BNN on March 21, 2007	Correcting the list of legal vaccines, probiotics, microbiology, and chemicals used in Vietnam promulgated in Decision No. 11/2007/QĐ-BNN on 06/02/2007.
2007	Decision No. 768/2007/QĐ-BNN on March, 21, 2007	Correcting the list of legal, illegal and restricted veterinary drugs in Vietnam promulgated in Decision No. 12/2007/QĐ-BNN on 06/02/2007.
2007	Decision No. 65/2007/QĐ-BNN on July 03, 2007	The additional list of animal feeds, animal feed ingredients permitted to import in Vietnam
2008	Decision No. 41/2008/QĐ-BNN on March 05, 2008	The list of legal, illegal and restricted veterinary drugs in Vietnam
2008	Decision No. 42/2008/QĐ-BNN on March 05, 2008	The list of legal vaccines, probiotics, microbiology, and chemicals used in veterinary in Vietnam.
2008	Decision No. 88/2008/QĐ-BNN on August 22, 2008	The list of animal feeds and animal feed ingredients permitted to import into Vietnam by HS code.
2008	Direction No. 3246/CT-BNN-PC on Oct 31, 2008	Strengthening the management, inspection and handling of violations in production and commerce of animal feeds, fertilizers, veterinary drugs and plant protection drugs.
2008	Decision No. 186/QDD-CN-TACN on Oct 31, 2008	Promulgating regulations on general requirements on ability of testing laboratories for animal feeds.
2008	Decision No. 187/QĐ-CN-TACN on Oct 31, 2008	Promulgate regulations on assessment and appointment of testing laboratories for animal feeds.
2008	Guideline No. 1259/CN-TTCP on Nov 1, 2008	Guiding the implementation of inspection, examination and handling of violations in the field of animal feeds.
2008	Decision No. 4015/QĐ-BNN-CN on Dec 17, 2008	Temporarily appointing laboratories for testing and analysing Melamine in raw materials and animal feed, aquaculture.
2008	Official Dispatch No. 1492/CN-TACN on Dec 31, 2008	Testing Melamine in raw materials and imported animal feeds.
2009	Decision No. 172/QĐ-BNN-CN on Jan 20, 2009	Appointing additional laboratories for testing analysing Melamine in raw materials and animal feeds, aquaculture.
2009	Circular No. 15/2009/TT-BNN on March 17, 2009	The list of legal, illegal and restricted veterinary drugs, chemicals and antimicrobials.
2009	Circular No. 18/2009/TT-BNN on March 30, 2009	The list of legal veterinary drugs in Vietnam.
2009	Circular No. 19/2009/TT-BNN on March 30, 2009	The list of legal vaccines, probiotics, microbiology, and chemicals used in veterinary in Vietnam.

2009	Circular No. 51/2009/TT-BNNPTNT on August 21, 2009	Regulations on inspection and certification of eligibility for production and commerce of veterinary drugs, biological products, microorganisms, chemicals used in veterinary medicine, aquatic veterinary medicine.
2009	Decision No. 81/2009/TT-BNNPTNT on Dec 25, 2009	Promulgating national technical standards on animal feeds.
2010	Decreee No. 08/2010/NĐ-CP on Fec 05, 2010	Management on animal feeds
2010	Circular No. 18/2010/TT-BNNPTNT on April 2, 2010	The list of legal veterinary drugs in Vietnam
2010	Circular No. 19/2010/TT-BNNPTNT on April 2, 2010	The list of legal vaccines, probiotics, microbiology, and chemicals used in veterinary in Vietnam.
2010	Circular No. 20/2010/TT-BNNPTNT on 02/4/2010	Supplementing and amending Circular No. 15/2009/TT-BNNPTNT on 17/3/2009 promulgating the list of illegal and restricted veterinary drugs, chemicals, and antimicrobials.
2011	Decree No. 08/2011/NĐ-CP on Jan 25, 2011	Regulations on sanctioning administrative violations on animal feeds.
2011	Circular No. 31/2011/TT-BNNPTNT on April 21, 2011	The list of legal veterinary drugs in Vietnam.
2011	Circular No. 32/2011/TT-BNNPTNT on April 21, 2011	The list of legal vaccines, probiotics, microbiology, and chemicals used in veterinary in Vietnam.
2011	Decision No. 467/QĐ-BNN-TC on April 08, 2011	Approving the detailed cost of the program of food safety and hygiene inspection, quality of animal feed in 2011
2011	Circular No. 66/2011/TT-BNNPTNT on Oct 10, 2011	Detailing a number of articles of Decree No. 08/2010/ND-CP on management of animal feeds.
2011	Official Dispatch No. 1421/QLCL-KN on Nov 24, 2011	Certification of registration certificate for verification of quality of imported animal feeds.
2011	Official Dispatch No. 3458/BNN-CN on Nov 24, 2011	Exempting tax on some kinds of imported animal feeds.
2011	Decision No. 312/QĐ-CN-TACN on Nov 28, 2011	Appointing testing laboratories for animal feeds.
2011	Circular No. 81/2011/TT-BNNPTNT on Dec 01, 2011	Amending and supplementing Clause 1, Article 36 of Circular No. 66/2011/TT-BNNPTNT detailing a number of articles of Decree No. 08/2010/ND-CP on management of animal feeds.

2012	Circular No. 03/2012/TT-BNNPTNT on Jan 16, 2012	Amending and supplementing Circular No. 15/2009 / TT-BNN on 17/3/2009 promulgating the List of illegal and restricted veterinary drugs, chemicals and antibiotics.
2012	Circular No. 23/2012/TT-BNNPTNT on June 18, 2012	Amending and supplementing circular No. 81/2009/TT-BNNPTNT promulgating national technical standards on animal feeds.
2012	Circular No. 26/2012/TT	Promulgating a temporary list of cattle and poultry feeds permitted for circulation in Vietnam.
2012	Circular No. 41/2012/TT-BNNPTNT on August 15, 2012	Promulgating national technical standards on assay and verification of livestock breeds and animal feeds.
2013	Circular No. 28/2013/TT-BNNPTNT on May 31, 2013	The list of legal vaccines, probiotics, microbiology, and chemicals used in veterinary in Vietnam.
2013	Official Dispatch No. 3305/BNN-CN on Sept 16, 2013	Appling HS codes of imported animal feeds.
2013	Official Dispatch No. 3514/BNN-CN on Oct 02, 2013	HS codes for raw materials of animal feeds.
2013	Decree No. 119/2013/NĐ-CP on Oct 09, 2013	Regulations on sanctioning administrative violations in the field of veterinary drugs, animal breeds and animal feeds.
2013	Official Dispatch No. 1341/QLCL-KN on Aug 05, 2013	Developing standard analysis procedure for Aflatoxins in agricultural products and animal feeds.
2013	Official Dispatch No. 1644/CN-TACN on Dec 12, 2013	Identifying imported feather feed powder.
2014	Decision No. 3112/QĐ-BNN-CN on July 14, 2014	Promulgating the plan of key inspection of animal feed quality in 2014.
2014	Circular No. 28/2014/TT-BNNPTNT on Sep 04, 2014	Promulgating a list of chemicals and antibiotics prohibited from import, production, commerce and utilization in animal and poultry feeds in Vietnam.
2014	Circular No. 50/2014/TT-BNNPTNT on Dec 24, 2014	Amending and supplementing circular No. 66/2011/TT-BNNPTNT detailing a number of articles of Decree No. 08/2010/ND-CP on management of animal feeds.
2014	Direction No. 10318/CT-BNN-QLCL on Dec 25, 2014	Implementing urgent measures to control antibiotic residues in aquaculture production and export.
2015	Direction No. 1865/CT-BNN-TY on March 04, 2015	Strengthening management of production, commerce and utilization of antibiotics in animal husbandry and aquaculture production to ensure food safety.

2015	Law on Veterinary No. 79/2015/QH13	
2015	Circular No. 29/2015/TT-BNNPTNT on Sep 04, 2015	Amending and supplementing circular No. 66/2011/TT-BNNPTNT detailing a number of articles of Decree No. 08/2010/ND-CP on management of animal feeds.
2015	Circular No. 42/2015/TT-BNNPTNT on Sep 16, 2015	Promulgating the additional list of chemicals and antibiotics prohibited from import, production, commerce and utilization in animal and poultry feeds in Vietnam.
2016	Circular No. 06/2016/TT-BNNPTNT on May 31, 2016	On May 31, 2016, the Ministry of Agriculture and Rural Development issued Circular No. 06/2016/TT-BNNPTNT on the list and content of antibiotics allowed to be used in cattle and poultry feeds for growth promotion in Vietnam. This circular takes effect from July 15, 2016, and is applicable to organizations and individuals trading and using cattle and poultry feeds in the territory of Vietnam. The circular also stipulates the content (minimum - maximum) for use in completed compound feeds (mg of antibiotics/kg of feed) of 15 antibiotics allowed to be used in chicken and quail feeds (from 1 to 28 days old); feeds for laying chickens and quails; feeds for pigs (less than 60 kg body weight); content (minimum - maximum) allowed to use of 15 antibiotics in mixed feeds for calves under 6 months old (mg antibiotics/kg feed)...
2016	Circular No. 10/2016/TT-BNNPTNT on June 01, 2016	The list of legal and illegal veterinary drugs in Vietnam, announcing HS codes for legal imported veterinary drugs permitted in Vietnam.
2016	Circular No. 13/2016/TT-BNNPTNT on June 02, 2016	Regulations on management veterinary drugs.
2016	Circular No. 27/2016/TT-BNNPTNT on July 26, 2016	National technical standard on animal feed stipulating maximum levels of toxins, heavy metals and microorganisms in compound feeds for cattle.
2016	Circular No. 36/2016/TT-BNNPTNT on Dec 26, 2016	On December 26, 2016, the Minister of Agriculture and Rural Development issued Circular No. 36/2016/TT-BNNPTNT amending and supplementing Article 4 of Circular No. 06/2016/TT-BNNPTNT dated 31/05/2016 promulgating the list of legal antibiotics in cattle and poultry feeds for growth promotion in Vietnam. This circular takes effect on February 8, 2017.

2017	Circular No. 01/2017/TT-BNNPTNT on Jan, 16, 2017	Supplementing the list of chemicals and antibiotics prohibited from import, production, commerce, and utilization of cattle and poultry feeds in Vietnam, the list of toxic chemicals having adversely effects on the environment.
2017	Decree No. 39/2017/NĐ-CP on April 04, 2017	Accordingly, legal livestock and aquaculture feeds in Vietnam must meet the following requirements: - Must announce the applicable standards in accordance with the regulations and have quality consistent with the applied standards; announce of conformity as prescribed in the respective national technical regulations (if any); - Each product with one published quality standard can have only one corresponding trade name; - For new livestock and aquaculture feeds, after being recognized by the Ministry of Agriculture and Rural Development, if there is a need for circulation, they must announce the applicable standards and announce the conformity as prescribed. In addition, livestock and aquaculture feeds manufactured for internal consumption or conventional feeds are not required to register for circulation but must meet the requirements of the respective national technical standards. Decree 39/2017/ND-CP takes effect from May 20, 2017 and replaces Decree 08/2010/ND-CP.
2017	Circular No. 20/2017/TT-BNNPTNT on Nov 11, 2017	Guiding Decree No. 39/2017/NĐ-CP on management of livestock and aquaculture feeds promulgating by Ministry of Agriculture and Rural Development.
2017	Decree No. 41/2017/NĐ-CP on April, 05 2017	Amending and supplementing some articles of the decrees on sanctioning administrative violations in fishery activities; veterinary, livestock breeds, animal feeds; forest management, forest development, forest protection and forest product management.
2017	Decision No. 2625/QĐ-BNN-TY on June, 21, 2017	Promulgating the "National action plan on antimicrobial use management and antimicrobial resistance prevention in animal husbandry and aquaculture in the 2017-2020 period.
2017	Decree No. 100/2017/NDD-CP on Aug 18, 2017	Amending and supplementing Decree 39/2017/NĐ-CP on management of livestock and aquaculture feeds promulgating by Ministry of Agriculture and Rural Development.
2017	Official Dispatch No. 1525/CN-TACN on Sep 19, 2017	Reviewing procedures and register for inter-agency testing of animal feeds.
2017	Official Dispatch No. 10375/BNN-TTr on Dec 14, 2017	Chemicals used in animal feed production and commerce.

2018	Decree No. 64/2018/NĐ-CP on May 07, 2018	Regulations on sanctioning administrative violations in the domain of livestock breeds, animal feeds and aquaculture products
2018	Circular No 34/2018/TT-BNNPTNT on Nov 16, 2018	Amending circular No. 33/2014/TT-BNNPTNT and 20/2017/TT-BNNPTNT
2018	Law on animal husbandry, No. 32/2018/QH14, dated Nov 19, 2018	**Article 12. Acts strictly prohibited in animal husbandry:** **Clause 3.** Use of antibiotics in animal feed other than veterinary drugs permitted for circulation in Vietnam. **Clause 4.** To use antibiotics in animal feed to stimulate growth.
2019	Circular No. 02/2019/TT-BNNPTNT on Feb, 11, 2019	Promulgating a list of conventional animal feeds according legal raw materials in Vietnam.
2019	Circular No. 21/2019/TT-BNNPTNT on Nov, 28, 2019	Guiding some articles of the Law on livestock production.
2020	Decree No. 13/2020/NĐ-CP on Jan 21, 2020	Guiding Law on livestock husbandry in details.

Chapter 5 – Table 1: A summary of farmers' KAP towards ABU and ABR

Items	Types of farms		
	Total (n=100)	Chicken (n=53)	Pig (n=47)
Possible effects of AB abuse to animals	100	53	47
Severe	84	46 (86.8%)	38 (80.9%)
Mild	16	7 (13.2%)	9 (19.1%)
No idea	0	-	-
Possible effects of AB abuse to farmers' health	100	53	47
Severe	23	12 (22.6%)	11 (23.4%)
Mild	62	32 (60.4%)	30 (63.8%)
No idea	15	9 (17%)	6 (12.8%)
Possible effects of AB abuse to consumers' health	100	53	47
Severe	52	25 (47.2%)	27 (57.4%)
Mild	34	18 (34%)	16 (34%)
No idea	14	10 (18.9%)	4 (8.5%)
PRACTICES			
Reasons for using ABs	96	51	45
For only therapeutic purposes	39 (40.6%)	18 (35.3%)	21 (46.7%)
For non-therapeutic purposes	57 (59.4%)	33 (64.7%)	24 (53.3%)
Self-increasing dosage of ABU	78	39	39
Yes	52	24 (61.5%)	28 (71.8%)
No	26	15 (38.5%)	11 (28.2%)
Self-decreasing dosage of ABU	78	39	39
Yes	34	17 (43.6%)	17 (43.6%)
No	44	22 (56.4%)	22 (56.4%)
Self-adjusting dosage of ABU	78	39	39
Yes	60	28 (71.8%)	32 (82.1%)
No	18	11 (28.2%)	7 (17.9%)
ATTITUDES			
Assessing antibiotic need	100	53	47
Very necessary	26	18 (34%)	8 (17%)

Necessary but not too essential	63	30 (56.6%)	33 (70.2%)
Not necessary	6	3 (5.7%)	3 (6.%)
No answer	5	2 (3.8%)	3 (6,4%)
Intention of reducing ABU	100	53	47
No	69	36 (67.9%)	33 (70.2%)
Yes	31	17 (32.1%)	14 (29,8%)

Chapter 6 – Table 1: Risk judgment and farming safety judgment *

Judgment	Low to no risk	High risk	Total	P-value
Unsafe farming practices	19 (29.7%)	15 (57.7%)	34 (37.8%)	0.01
Safe farming practices	45 (70.3%)	11 (42.3%)	56 (62.2%)	
Total	64 (100%)	26 (100%)	90 (100%)*	

* Excluding 10 cases with no idea about risk judgment.

Chapter 7 – Table 1: Characteristics of farmers divided by three groups

		Pioneer farmers (n=14)	Hesitant farmers (n=29)	Conventional farmers (n=38)
Farming scale	Household (n=14)	-	8 (27.6%)	4 (10.5%)
	Small scale (n=35)	5 (35.7%)	9 (31%)	21 (55.3%)
	Medium size (n=34)	9 (64.3%)	12 (41.4%)	13 (34.2%)
Farming types	Chicken (n=40)	8 (57.1%)	10 (34.5%)	22 (57.9%)
	Pig (n=41)	6 (42.9%)	19 (65.5%)	16 (42.1%)
Gender	Female (n=28)	6 (42.9%)	9(31%)	13 (34.2%)
	Male (n=53)	8 (57.1%)	20 (69%)	25 (65.8%)
Participating in training events	0-1 time	4 (28.6%)	10 (34.5%)	10 (26.3%)
	>=2 times	10 (71.4%)	19 (65.5%)	28 (73.7%)
Level of education	Primary	4 (28.6%)	6 (20.7%)	10 (26.3%)
	Secondary	7 (50%)	11 (37.9%)	21 (55.3%)
	High school & above	3 (21.4%)	12 (41.4%)	7 (18.4%)
Level of ABU understanding	Not good	2 (14.3%)	14 (48.3%)	13 (34.2%)
	Moderate to good	12 (85.7%)	15 (51.7%)	25 (65.8%)
Level of ABR understanding	Not good	1 (7.1%)	7 (24.1%)	11 (28.9%)
	Moderate to good	13 (92.9%)	22 (75.9%)	27 (71.1%)
Age (Median, IQR)		**55 (49,58)**	**46 (36, 57)**	**47 (39, 53)**
Years of farming experience (Median, IQR)		**13 (10,17)**	10 (5,15)	**10 (5,15)**

Chapter 8 – Table 1: Farmers' perceptions and a personal frame of reference

	Pioneer farmers	**Hesitant farmers**	**Conventional farmers**
Perception of farming landscape			
Changes	Commercial targeted farming Professional occupation (or full-time job)		
	The need for applying scientific knowledge and technology into animal farming	Not mentioned	Not mentioned
Favourable factors	The accessibility of commercial feed The availability of veterinary drugs		
	Plentiful sources of information, & active learn	Plentiful sources of information	
	The development of rural transport infrastructure		
Challenges	- High density of animals - Environmental degradation & pollution	- High density of animals - Environmental degradation & pollution Market pressures Animal diseases	- Environmental degradation & pollution - Unregulated farming operation -
Personal frame of reference			
Farming goals			
Production	Highest values of livestock production	Highest quality of animal products	Stable economic profits
Income	For personal income	For household income	For both personal and household income
Personal circumstance	Not mentioned	Being suitable for health conditions	Not mentioned

	Be suitable for an old age Not having other jobs		
Autonomy	Being economic independence with children	"Being own boss"	"Flexibility in managing time"
Lifestyle	For enjoying healthy lifestyle Being happy with challenges		
Beliefs about livestock husbandry			
Controlling animal diseases	If animal diseases were well controlled, production efficiency would be ensured		
Producing high products	if farm products meet requirements of good quality and safety, they would get higher commercial value		Not mentioned
Basing on scientific knowledge	commercial production required an application of scientific solutions for farming management and response, rather than just traditional experiences	Not mentioned	Not mentioned
Connecting farm household	the value of farm products would be increased if there is a connection between farm households	Not mentioned	Not mentioned
Beliefs about ABU			
Highlighting the	Abs are essential in treating animal diseases		

necessity of AB			
ABU benefits	Not mentioned	Not mentioned	Benefits of sub-therapeutic use
Negatives effects to animal health	Negative effects to animal health		Not mentioned
Negative effects to human health	Negative effects to human health		Not mentioned
Beliefs about self-efficacy			
Be confident with alternatives	*My solutions are effective*	Not mentioned	Not mentioned
Be not confidents with alternative	Not mentioned	Unsuccessful experience with alternatives to antibiotics	Not mentioned
Having no ideas	Not mentioned	Not mentioned	Having no ideas about alternatives to antibiotics
Using AB in a 'considered manner"	Not mentioned	Already using Abs with considerations	
Moral values			
Economic benefits	Working on farms for personal income or household income		
Household welfare	Not mentioned	All changes could put their family at risk of losing livelihood	Not mentioned
Animal welfare	***Responsibility and competence***	***Sensitiveness*** "*I can hear and*	***Humanities*** *"Animals are like*

	"We will do everything that is the best for my animals, no one can understand my animals better than I can" (A pioneer farmer from a medium sized pig farm)	*distinguish their noise, as their normal communication together or the expression of their fear or stress*" (A hesitant farmer from a medium sized chicken farm)	*people"* (A conventional farmer from a medium sized pig farm) "*the piglets show their happiness when living with their moms…"* (A conventional farmer from a medium sized pig farm)
Customers' food safety	Reducing ABU for non-therapeutic purposes could bring more benefits to human health by preventing antibiotic residue.		the regular use of antibiotics with a sub-therapeutic dose was beneficial to human health by controlling the withdrawal period of antibiotic administration as well as reduce the risk of antibiotic residue remaining in food products
Motivation			
Economic profits	Yes	Yes	Yes
For animal welfare	Yes	Yes	Yes
For animal food safety to	Yes	Yes	Not prioritized

customers' benefits			
For the value of livestock husbandry	Yes	Not mentioned	Not mentioned
Categorizing farmers			
Intention of AB reduction	Only using ABs for treatment	Desire to reduce ABs	No desire to reduce ABs
Alternatives to antibiotics	Having effective alternative solutions	Not having effective alternative solutions yet	Not applicable
Favourable conditions	A well-formed perception of the farming landscape	A quite well-formed perception of the farming landscape	
Vision	Long term vision	Short term vision	
The top concerns	The development of livestock husbandry	Food safety for consumers versus household income	Economic profits

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